PUBLISHED EVERY SATURDAY BY
THE W. J. JOHNSTON COMPANY, Limited,
167-177 TIMES BUILDING, NEW YORK.
Established 1874. Incorporated 1889.
Telephone Call: Cortlandt 924. Cable Address: "Electrical," New York

New England Office, Room 28, Hathaway Building, 620 Atlantic Ave., Boston.
Western Office, 465 The Rookery, Chicago.
Philadelphia Office, 927 Chestnut Street.

SUBSCRIPTION, IN ADVANCE, ONE YEAR, $3.
(Including Postage in the U. S., Canada or Mexico.)
IN CLUBS of four or more, $2.50 a year each; with a free extra copy to the getter up of a club of 5. Foreign subscription, $6 a year.

In requesting your address changed, give **old** *as well as new address.*

ESTABLISHED 17 YEARS AGO, THE ELECTRICAL WORLD is the Pioneer Electrical Journal of America and has well maintained its lead. It has the LARGEST CIRCULATION of any electrical periodical in the world, and is the BEST ADVERTISING MEDIUM.

Correspondence, views and opinions on all topics within the province of this journal are cordially invited from any part of the world. We will thank readers to forward to us—**promptly** as they occur—**Items of News,** or information relating to any application of Electricity, also marked copies of their local papers containing anything likely to interest electricians. Anonymous communications cannot be noticed, nor can rejected manuscript be returned, unless accompanied by the necessary postage when received.

Advertising Rates are much lower than those of any other similar publication, circulation and standing considered, and vary according to space, position and number of insertions. Quotations promptly furnished.
Situation or Help Wanted advertisements $1 to $2 an insertion, according to length.

Address all communications to
THE W. J. JOHNSTON COMPANY, Ltd.
Times Building, New York,
OR ANY OF THE BRANCH OFFICES.

VOL. XVIII. NEW YORK, JULY 18, 1891. No. 3.

CONTENTS.

EDITORIAL: PAGE.
Paragraphs ... 39
ILLUSTRATED ARTICLES:
A Study of Indicator Diagrams ... 40
A Brooklyn Isolated Lighting Plant ... 41
The Electromagnet in Eye Surgery, by Prof. S. P. Thompson and J. Tatham Thompson ... 42
The Riverside Park Electric Railway, at Sioux City, Iowa ... 43
History of Electricity, Galvanism, Magnetism and the Telegraph, by P. F. Mottelay ... 43
Electrical Cable Testing.—IV., by Henry W. Fisher ... 45
Electrical Evaporation, by Prof. Wm. Crookes ... 46
High-Tension Experiments ... 47
The Collier Audible Telephone ... 47
The Wurts-Winsor Lightning Arrester ... 48
An Edison Mining Drill ... 49
Street-Railway Work in Lincoln, Neb. ... 49
Decision in the Lamp Patent Case ... 55
MISCELLANEOUS:
Latest Foreign Electrical News ... 40
The Electrical Executions at Sing Sing ... 40
The Most Economical Loss in Conductors, by Prof. E. P. Roberts ... 41
Curious Cause of Electrical Faults ... 42
A Small 500-Volt Motor ... 49
A Gravel-Pit Plant ... 49
FINANCIAL INTELLIGENCE: The Electrical Stock Market, 50; New Incorporations, 50; Affairs of the Companies, 50.
SPECIAL CORRESPONDENCE: New York Notes, 50; New England Notes, 50; Western Notes, 50; Philadelphia Notes, 50; Southern Notes, 51; English Notes, 51.
ANSWERS TO CORRESPONDENTS ... 52
NEWS OF THE WEEK: The Telegraph, 52; The Telephone, 52; The Electric Light, 52; The Electric Railway, 53; Personals, 53; Educational Notes, 53; Miscellaneous Notes, 53.
INDUSTRIAL AND TRADE NOTES ... 53
OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS ... 54

Decision in the Great Lamp Case. JUDGE WALLACE has at last rendered his decision in the incandescent lamp suit, and its character is such as to cause surprise even to the always confident friends of the great Edison interests. The full text of the decision is given in a special supplement to the present number of THE ELECTRICAL WORLD. In general it is a strong affirmation of Mr. Edison's claims to the invention of the practical incandescent lamp of to-day. The technical weakness alleged against the patent—the anticipation of high-resistance lamps by Lane-Fox and Edison himself, the frequent use of carbon in incandescent lamps, the well known availability of platinum leading wires, the rejection of claims identical with those of Edison for lack of novelty and invention—all these are passed over almost in silence, and the decision rests really upon the patent influence of Edison's work on the art of incandescent lighting. The case will undoubtedly be taken to the Circuit Court of Appeals for final decision.

The Electromagnet in Surgery. PROF. THOMPSON'S note on the use of the electromagnet as a surgical instrument will prove an interesting suggestion to most of our readers. Few people realize how important are the various applications of electricity in medicine aside from the actual effects of the electric current. Not only has electric cautery found its way into rather general use among surgeons, but the incandescent lamp has been applied in a large variety of ways for the purpose of investigating diseased portions of the organism. The electric motor has proved useful in actuating some bits of surgical apparatus, and the induction balance and electric probe have been freely used in tracing out the position of foreign bodies which have unfortunately found their way into the human frame. The electrician seats himself in a dentist's chair and is promptly treated to a dose of his own medicine in the shape of a buzzing drill with an electric motor at the other end of the line; he gets a bit of steel in his eye and it is pulled out with an electromagnet; it has even been suggested that something about the interior construction of his head might be determined by inspecting it by the aid of one of his own incandescent lamps. Beside all this there is much to be learned concerning the application of electricity as a remedial agent. It has been looked at somewhat askance for the reason that it has fallen to some extent into the hands of quacks, but, nevertheless, its field of usefulness has widened in spite of this drawback, and the time may come when its medical uses will be almost as familiar to us as its mechanical ones.

A Victory for the Trolley. THE "deadly trolley" has just scored another point against the unreasonable opposition that has greeted all attempts to secure rapid transit in and about New York City. While the recent decision of the railway commissioners concerning the Atlantic Avenue line in Brooklyn is not of itself sufficient to obviate all the difficulties that will be met, it certainly seems as if Brooklyn might eventually get electric rapid transit, and Brooklyn needs it as every other large city does. The comments of the press have, as usual, been caustic, at the expense of the railway commissioners, however, instead of the street railway company. It is rather tiresome to hear a repetition of the same weary old yarns about the desperate character of the trolley wire and its thorough-going malevolence at every favorable opportunity. Especially is it exasperating to hear again the venerable story of the great fire in Boston charged up against the electric current, apparently for the reason that the actual cause was not found. The number of fires directly traceable to electricity is very small indeed, but nothing seems to overcome the tendency of the average mind to look for the nearest electric wire in case of a mysterious fire—it makes no particular difference whether it is a live wire or a dead wire, whether it runs into the burning building or is on the next block; in either case the wonderful fluid is supposed in some occult way to have found a path in which to exercise its predilection for arson. Probably a few years more of experience with the "deadly trolley" will convince the public of its comparative innocence, and whatever we may hope for the storage battery and conduit electric traction, it must be remembered that the trolley system is a commercial success, while the others have yet their reputations to make. There have been recently some rather successful experiments with the storage battery in this country, and abroad a single conduit road—that in Budapest—has made an excellent record; but the overhead system has proved its merit, and though it may not be ideal it is intensely practical and useful.

Elementary Electrical Training. ELSEWHERE in our columns this week will be found a brief note concerning the proposed establishment of a school for elementary electrical training in this city. Enterprises such as this ought to have the unqualified approval of the public That there is need of widespread facilities for the acquirement of at least the rudiments of electricity, popular ignorance only too clearly shows, and anything that can change this state of things is in itself highly desirable. There are now in the country plenty of schools of electrical engineering, so called; most of them are good, and all of them are capable of giving a fair theoretical training, but unfortunately they do not reach the masses. To enter most of them a considerable amount of hard preliminary training is required and the courses themselves extend over several years, involving residence at one of our colleges or universities. Of the practical value of an education thus acquired there can be no doubt, for the demand to-day is for educated electricians, but nevertheless there are thousands who cannot avail themselves of these privileges. There are in the various electrical industries a great many bright young men who have not had the advantage of anything but a limited common-school education and who are willing and anxious to learn all that their circumstances permit of modern applied electricity. They have not the time nor the money to spend in taking a thorough course of electrical training, but with even a little help they would be able to improve their minds and their situations to a very considerable extent. For this class of students—the rank and file of working electricians to-day—there is at present little chance, and they certainly deserve a great deal of consideration, for however skillful a supervising electrical engineer may be, much of the success of his work will depend on the ability and training of his subordinates. A special feature of the proposed school would be the establishment of evening classes as well as day classes, and, while the latter will be of great service to those just entering on their technical studies, the former will meet exactly the demand to which we have referred. By all means let us have a school for elementary work in practical electricity a school beginning at the very beginning and thoroughly practical all the way through. Such an enterprise richly deserves success, and there is little doubt that the interest in the subject will be such as to justify opening the doors of the new institution before the coming winter.

Arc Lighting Abroad. IT is agreeable to observe in recent notes from abroad the satisfactory impression that the arc light is making in London. We in America have become so thoroughly familiar with the effectiveness of powerful electric lamps for street lighting that it seems queer to think of the long period that has passed without adequate illumination in the streets of a great metropolis like the city of London. There are at present, to be sure, but 26 of the electric street lamps in operation, and all of these are on one street, but our foreign cousins have through this experiment discovered that the arc light is a very good thing for such purposes. This, of course, is the point of the wedge, and preparations are now being made for carrying on the work immediately on quite an extensive scale. The details seem to have been well worked out, and, in particular, one feature that has been introduced is worthy of adoption here; instead of the globes in general use in this country, the lights in London are placed in octagonal lanterns provided, not with plain glass, but with panes so molded as to disperse the light and give the effect of a luminous surface of considerable dimensions. Opal glass is also being tried, but the loss of light is so great that it is altogether probable that the molded glass so shaped as to scatter the rays effectively will give illumination far preferable to that ordinarily obtained in this country. It ought to be remembered in arc lighting that the usual distribution from the arc is a luminous zone perhaps 20 or 30 degrees wide and inclined downward at an angle of something like 45 degrees. A little tact in arranging the shape of the lantern will enable this condition to be very much modified. Of course similar devices have been tried here, but we have not yet arrived at a thorough appreciation of the best possibilities of artistic lighting with electricity, either arc or incandescent. A little skill will not only obviate the very dense shadows that characterize arc lighting, but will also soften the glare of the incandescent lamp in a way that will fit it for domestic illumination much better than at present. Electric lighting as an industry is eminently successful and its development is in a very satisfactory stage; electric illumination as an art, however, has not received at all the attention its importance deserves, and ten years from now one will probably be amazed to observe the evolution of ideas that has taken place with the little oval incandescent globe as its starting point.

The Electrical Executions. IN our last week's issue was given a brief note mentioning the execution by electricity of four condemned murderers at Sing Sing. On another page some few further details will be found. Through the unfortunate policy of secrecy that has been observed, the actual facts have been rendered almost inaccessible to the public, and data of considerable scientific importance have been, at least temporarily, suppressed. It is not known what voltage was employed in the fatal experiments, or what amount of current was actually passed between the electrodes. The best information obtainable places the electrical pressure at a little under 2,000 volts, which would indicate something less than an ampère as the probable current. The important lesson taught by the facts that are obtainable is that death was produced instantly and without pain. This might have been anticipated, in fact has been anticipated, by all those most thoroughly conversant with the action of high-tension currents, even although some doubts were raised by the questionable results of the Kemmler execution last year. At that time we expressed the opinion that insensibility was instantaneous and complete, and that death would certainly have been immediate had there been proper care in the preparations. This prediction is abundantly verified by the result of the executions at Sing Sing last week. On whatever points the witnesses may have disagreed, on this they all are united, that the condemned men died as if they had been struck by lightning, without pain and in an almost infinitesimal length of time. At that time, too, we suggested that in the Kemmler execution the position of the electrodes was unfortunate, both because the contact was ineffectual and because the heart was comparatively remote from the direct action of the current. Both these difficulties were avoided in the present case; but while this may have contributed to the result, no one can tell to what extent, since it probably never will be known what were the real causes of the comparative inefficiency of the apparatus at the first electrical execution. Capital punishment is not a pleasant subject for contemplation, and it is unfortunate that electricity should by statute be selected as the means for inflicting it, but nothing has been accomplished by the efforts made to repeal the law, and it is probable that even the quadruple execution of last week is less injurious to electrical interests than a prolonged agitation like that of a year ago.

Latest Foreign Electrical News.

(By cable from our own correspondent.)

London, July 13, 1891.—An item of importance to Americans is the recent statement in the House of Commons that the government proposes to give solid pecuniary support to the English exhibitors at the Chicago World's Fair in 1893. This is hopeful evidence of the interest that is taken in England in the international exposition that is now proposed. In spite of the difficulties that you seem to be having in America over the matter, foreign governments are willing to take an active part in making the exhibits of their respective countries as complete and representative as they should be, and you can rest assured that England, with its close commercial relations, both domestic and colonial, with the industrial work of the United States, will not remain behindhand in the good work.

A bill has just passed the House of Commons giving the London City Council full power to regulate all matters pertaining to the use of overhead wires. Interests have been previously rather divided in this respect, and possibly a new bill will enable work to be done in a more systematic way, although prejudice against overhead wires in this country is so strong that very little overhead work is likely to be permitted, particularly since the electric lighting of London has long passed its experimental stage, in which wires were somewhat freely permitted.

Some of the suggestions in the Board of Trade recently have been rather too favorable to the telephone companies to suit electric light interests, and we are pleased to note that these are being suppressed in the process of legislation on the granting of franchises.

An adjourned meeting of the shareholders of the City & South London Railway Company was held last week, to see whether any method could be devised for raising the additional capital required for this company's operations in a better or more economical way than the directors had proposed. The directors' proposals were adopted with but slight modifications, and it was decided to create £150,000 of authorized share capital in 15,000 preference shares of £10 each.

Mr. Carl Hering, special European correspondent of The Electrical World, arrived at Southampton on the 9th and is now in London.

A Study of Indicator Diagrams.

There is perhaps no more long-suffering piece of machinery in the world than the steam engine; when properly treated it is capable of faithful service year in and year out with hardly a wheeze or a grumble and never a breakdown, but if there were a society for the protection of abused steam engines half as active as the one for the prevention of cruelty to animals its officers would be kept continually busy, and the owners of engines would be in perennial hot water.

It might be supposed that it would be only the poorer class of engines in the hands of the ignorant and shiftless that would be allowed to become crippled through negligence, but such, unfortunately, is not the case, as the indicator cards given herewith bear sad witness. They are taken, we are sorry to say, from a fine Corliss engine, comparatively new, and engaged in the task of running an electric light plant in a building not a thousand miles from New York. For some little time the machine has been rebelling at the treatment it has been receiving, and eventually gave so much trouble that something had to be done. The plant had been pronounced all right by a so-called electrician who had examined it in its entirety, but nevertheless some attention was necessary. To cut a long story short, the machine fell into the hands of Mr. Thomas Pray, the well-known expert in steam engineering, who was kind enough to furnish the facts and indicator cards which are here given. The first two diagrams taken from the engine are shown in Figs. 1 and 2, and they are about as tough-looking specimens of the performance of a reputable and decent engine as have ever fallen under our notice. Not only were the two ends of the cylinder doing very unequal amounts of work, but both were doing it under great disadvantages. The valves were ridiculously and hopelessly wrong; instead of admitting steam for any definite portion of the stroke, the release was so sudden that the cut-off began almost before the valve was fairly open, and continued in a very sluggish way far beyond the point necessary; and this engine had been pronounced all right a few weeks before. The operation of the valves was so atrociously wrong that the most casual inspection of the valve gear ought to have shown the nature of the difficulty; but so long as a machine will run at all there are those who neglect all further details, and one of these astute individuals had evidently been inspecting the engine. A few changes in the valve motion (the accompanying cards showing the effect of the work) soon reduced the engine to apparently its proper performance, and resulted in the cards shown in Fig. 3, which has been carefully worked up. At first glance, neglecting the lines drawn for the purpose of showing the real state of the case, the card appears to be eminently satisfactory. By this time the two ends of the cylinder were balanced very exactly as to the work they were performing, the cut-off worked at the proper time and very promptly, and altogether the shape and general appearance of the card is such as would satisfy any reasonable engineer by its inspection. But the lesson to be learned from it is that appearances are deceitful, even in the case of indicator cards, and the necessity of something more than casual examination.

In Fig. 3 *A* is the atmospheric line of the indicator, *B* is the line of absolute vacuum, *C* the clearance in volume of the stroke, *D* the point from which the hyperbolic expansion curve is drawn, *E* the point of apparent cut-off as shown by the diagram, *F* the point at which the valve closed to give the pressure at *D*, *G* is the hyperbolic curve of the steam actually used from *D*, *H* is the expansion line of the indicator diagram, and *S* is the line of ste am pressure. On taking this apparently admirable card and drawing the hyperbolic curve *G*, it at once appears that something is radically wrong with the engine. The apparent and real diagrams evidently differ by an amount that is pretty serious, and the cause of this is to be found in the valves, which leak terribly. The steam actually used in the engine should do an amount of work shown by the area included by the lines *G A*, instead of the lines *H A*, as is the fact. In other words, the engine simply passes steam through the valves after the cut-off is supposed to have taken place, so that the expansion line is raised from *H* to *G*, and no work of any account is done with this wasted steam. The gap between the apparent and real diagrams is sufficient to indicate that the amount of steam lost is quite serious, and on computing from the

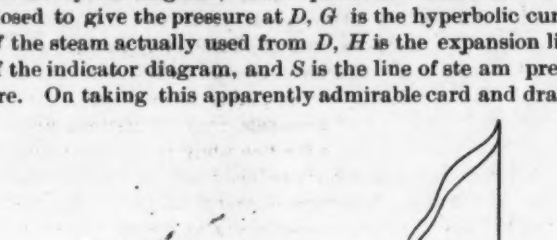


Fig. 1.—Corliss Engine Indicator Card.

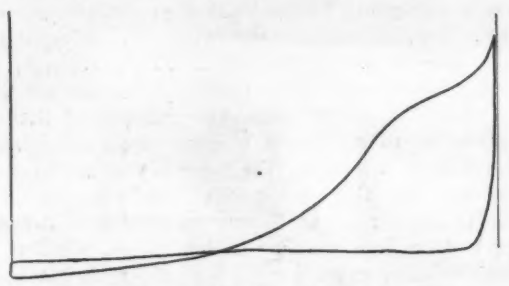


Fig. 2.—Corliss Engine Indicator Card.

card the amount of water per indicated horse power per hour actually used the result is 39.65 pounds, whereas with proper adjustment and decent care the engine ought to have done its work on something like 27 pounds of water per horse power hour. The result of this present condition of the engine is that the amount of coal burned is nearly double what it ought to be. Not only did the engine perform badly and give trouble at almost every turn, but it was eating into the coal pile at a rate that should have given a pang to the pocketbook of its owner. It was suggested to this astute gentleman by the engineer of the plant, a capable enough man but not familiar with indicator work, that it would be a good idea to have the engine set right by some one who was competent to do it; whereat

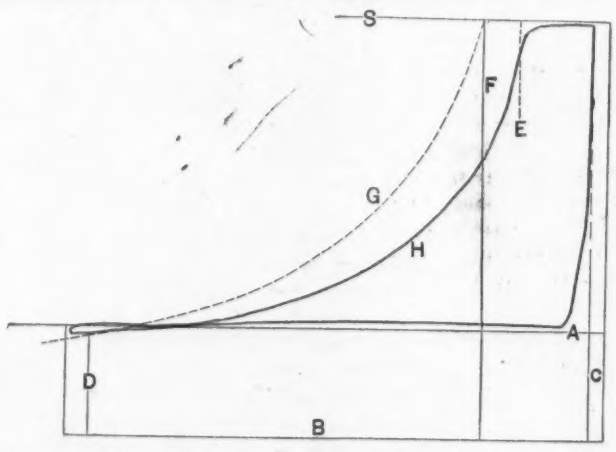


Fig. 3.—Corliss Engine Indicator Card After Adjustment of the Valves.

the amiable owner promptly responded that he would be damned if he would pay any man twenty-five dollars for fixing an engine which he knew to be all right. The fate suggested may not overtake him, but his coal pile is doomed.

The purpose of this little note on the very bad performance of what was originally a very good engine is to call the attention of our readers with as much force as possible to the necessity of looking after steam machinery. Watch critically the performance of engines. The understanding of the indicator, and the stories it tells of what is being done within the cylinder, to those who are unfamiliar with it sometimes seems only a play, of scientific interest perhaps, but decidedly useless to the "practical man." A little inspection of the present example may afford convincing proof that the study of the indicator diagram is just about practical enough to mean dollars and cents for those who have to pay the coal bills.

The Electrical Executions at Sing Sing.

On Tuesday morning, July 7, as briefly mentioned in our issue last week, four murderers paid the last penalty of the law by suffering death from electric shock. There was on this occasion very little of the extreme sensationalism that marked the Kemmler execution of August last; and yet, from a scientific point of view, the present executions were of no small importance, for their result would show whether or no electricity was to be relied upon as a means of execution, and whether its effects were instantaneous and certain. Among those best qualified to judge of the result of passing powerful alternating currents through the human body, there was no doubt concerning the result, no questioning of the deadly effect of the current when intelligently applied to kill. But the undoubted bungling in the Kemmler execution had caused much apprehension on the part of the public, an uncertainty that was fostered by electrical cranks and humanitarian enthusiasts. The electrical execution law was the result of a commission appointed by the New York Legislature about five years ago to inquire into the question of changing the mode of capital punishment. After a long period of investigation the commission reported in favor of electricity as a means of executing criminals, and on June 5, 1888, the present bill providing for this means of inflicting death was signed by the Governor and the law became operative on Jan. 1, 1889.

The extraordinary efforts made to save Kemmler will be remembered by most of our readers; they failed, but none the less the lawyers of the four condemned criminals who have just been executed made the most strenuous efforts in behalf of their respective clients. In the case of the prisoner Slocum the original judgment of the court was followed by a stay of proceedings and an appeal to the Court of Appeals. This body affirmed the judgment of conviction, but when the prisoner was brought up for re-sentence objections were made and a writ of habeas corpus was applied for; a little later this was denied by the judge before whom it was brought, and an appeal was then taken to the United States Supreme Court, which acted as a stay of execution. The Supreme Court declined to interfere.

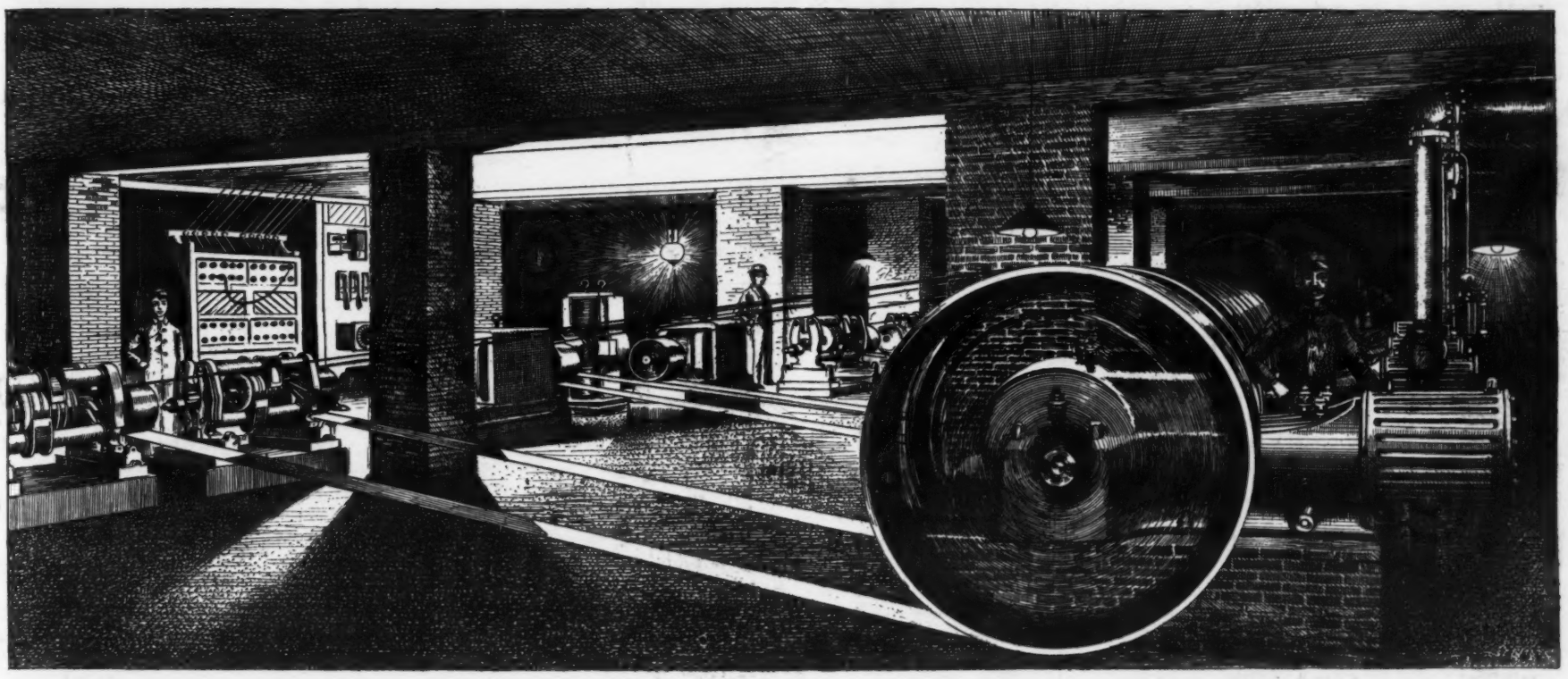
In the case of Smiler the course of legal proceedings was practically the same, and the execution was delayed from Aug. 3, 1890, to July 7 last. In behalf of Wood, the negro, much the same course was pursued, the case going from the original court to the Court of Appeals, and then to the United States Supreme Court; this, however, on the unusual ground that there were no negroes on the jury. This final appeal acted as a stay of execution, so, although he was ordered to be executed in the week beginning Dec. 2, 1889, he was saved for nearly nine months. In the case of Jugiro, an attempt was made to have electric execution declared unconstitutional as being a cruel and unusual form of punishment, but, like the others, this failed. It will be seen that every resource known to the law was exhausted to check the course of justice, and the legal quibblings for delay were so obvious as to call down a severe rebuke from one of the justices. As regards the actual execution details are hard to obtain, for the reason that the witnesses were bound to secrecy. Nevertheless, as might have been expected, much has leaked out. The four prisoners were killed instantly and painlessly, so quickly indeed that one of them died with a syllable half uttered upon his lips. As a precautionary measure the current was kept on about 20 seconds in each case, and after a short interval reapplied. There were, however, according to the best information that can be secured, no convulsive movements, and no indications of anything but dissolution, so immediately following the application of the current that it might well be compared to the result of a stroke of lightning. The electrodes were applied to the forehead and to one leg of each prisoner, and were kept wet during the application of the current. The only visible signs left upon the bodies were trifling superficial burns where the electrodes were applied. In one case a slight extension of the burning effect was observed, due to water from the electrodes carrying the current beyond the bounds of the area of true contact. From definite information received from one of the witnesses there was nothing in the least shocking or horrible in the whole course of the execution; there was no repetition of the startling convulsions in the Kemmler case, no suggestions of returning consciousness. Hasty autopsies were made at the end of the executions, and so far as the result of them is at present made known, the conclusion was that the four men died from shock at the very instant of application of the current. There were no serious internal lesions of any sort. It is now quite well established that death from electric shock takes place through the action of the current directly upon the heart, and hence no other result was to be anticipated. So far as instantaneous and painless death can be considered a success, electrical execution has succeeded. It is most unfortunate that electricity was the agent selected for inflicting capital punishment, as there undoubtedly must be some tendency to bring it into disrepute as dangerous to the public not yet familiar with the laws of its action. Nevertheless, it cannot be denied that the electric current, when deliberately applied for the purpose of killing, is most effective in its action.

Altogether, the present executions leave a painful impression that the death of Kemmler last year was accom-

panied by the most dreadful bungling, to say the least, and that, from some cause which it is to be hoped was accidental, the apparatus was in such a condition as ill fitted it for accomplishing the intended result.

A Brooklyn Isolated Plant.

The accompanying illustration shows a well designed and substantially constructed isolated lighting plant in one of the stores of Wechsler & Abraham in Brooklyn. As will be seen the plant includes quite a number of dynamos of different types, all of which, however, are driven by high-speed engines directly connected to the dynamos. The dynamo outfit consists of four 50-light arc machines of the Easton type, three 30-arc light machines of the Excelsior Company's manufacture, two 250-light incandescent dynamos of the Continental type and one 200-light Excelsior machine. Besides the dynamos there are two motors, one of which is a five h. p. Continental machine and the other a one h. p. C. & C. The engine outfit includes three Ball engines, two of which are of 100 h. p. each, and the other being a 50 h. p., and in addition to these there is a Corliss engine of 100 h. p. used in the plant. Schieren and Schulz belts are used for the direct connection between the dynamos and engines. The wiring and installation work was done by the Tucker Electrical Construction Company of this city and by the Excelsior Company. As will be seen from the illustration, the dynamo and engine room is neatly kept, the wiring running from the switchboards being almost entirely concealed. The switchboard is shown against the wall at the left in the illustration and from it it is possible to control the entire equipment of lights throughout the large building. Both arc and incandescent lights are used because many places in the store are much better lighted with incandescents, while there are others to which the arc lights are better suited.



AN ISOLATED ELECTRIC LIGHTING PLANT IN BROOKLYN.

Faraday as an Elder.

Some curious reminiscences of Faraday are given, of all places, in the *Referee*, says the London *Electrical Engineer*, by our humorous and pathetic friend "Dagonet" (Mr. G. R. Sims). It seems that the present Mr. Sims and his father knew the great man in a peculiar way. They were of the persuasion known as Sandemanians, and worshiped in a little court off Aldersgate street. The Sandemanians were Bible Christians, and their faith was simple and primitive in the extreme. Michael Faraday was an elder of this chapel, with a butcher, a gasfitter and a linendraper. In 1856 Faraday, on his own confession, was "put away" from them because his scientific researches had unsettled his belief. The gasfitter and butcher were shocked and stern. They all prayed for him, asking that light might be sent to his darkened brain. The prayers were answered. After a separation of some months, the great Michael Faraday—the man whom all the world delighted to honor—came back one day to the little meeting-house in Paul's alley, and, standing up before the little congregation—the Sandemanians were a very small body—made full confession of his error with tears in his eyes. Every one wept, and a blessed peace fell on the little meeting-house. Faraday, Mr. Sims remembers best as an elder, though he often met him at the elder Mr. Sims' house at Peckham. He had a very winning way with children and they all liked him. The Sandemanians liked him very much as a man, but they preferred the butcher as a preacher, and they considered it a terrible thing for a good man to devote himself to such doubtful subjects as electricity, instead of reading the Bible and being satisfied with things as they were.

The Most Economical Loss in Conductors.—I.

BY PROF. E. P. ROBERTS.

Although a very considerable number of papers have been published relative to the most economical size of conductor* for any given case, nevertheless the importance of the subject is not yet fully appreciated by investors, nor by so-called "practical" men. The formulæ presented by men "of theory" have not usually appealed to practical men, because they either were not at all applicable to cases generally arising, or because they seemed to apply, but the deduction therefrom was evidently "bad practice." For planning wiring, judgment must supplement formulæ. The use of formulæ may be the means of reaching an approximate solution, with a minimum of work, and then the man who has been able to handle the formulæ, and is also a practical man of affairs, will consider the "whys" and "wherefores," and finally arrive at a result which will give, probably, the most economical size of conductor for any given case, considering all the variables entering the problem during the planning, the erection, the operation in the immediate future and the most probable changes necessitated by growth, or otherwise, in the more distant future.

If the above statement is correct, it follows that the man competent to design the line for an electric light or power plant is not the student who can work out a complicated network system and give the drop at any point for any current and has not, in addition, knowledge of the financial questions of actual operation. Neither is he the lineman who has run hundreds of miles of wire and, therefore (?), knows all about it. The right man is the student who has had practice. The students of technical schools, who have had construction work and managed electric light plants, have, in this line of design, an opportunity which, so far, has been greatly neglected, owing to the fact that its importance has not been inculcated in their studies, and because the majority of cases arising in practice follow precedent, with more or less blindness. In fact, the subject has been considered by many, although, fortunately, not by all, as of little importance. As a matter of fact it is almost, and sometimes quite, as important economically that the size of the conductor be correctly proportioned as that the engine and dynamo units be properly chosen. The whole subject of the planning of a system of electric conductors, both as to maximum economy of loss of energy and the supplying of the best service with the least expense for repairs and minimum first cost, is one which can be studied with interest and profit by the electrical engineer.

It is a remarkable fact, which has been often noted, that investors in engineering projects very generally hesitate to pay for expert advice any sum commensurate with that which they would pay a lawyer for advice involving an equal amount of money. Also that for the erection of plants they hesitate to engage a supervising engineer at the same rate, possibly five per cent., which they would pay an architect. This is particularly true with regard to any question of line work, and is, unfortunately, the case with many who might be supposed to have some knowledge of the subject. It is a fact that for many cases the use of wire of a certain size would result in one or two per cent. dividend more than that declared if some other size were used. For a given total weight of copper in an incandescent plant, the proper proportioning and planning of the wire may easily make a difference of five per cent., more or less, in the dividends, because of the better regulation obtained when the total weight of wire is distributed to the best advantage.

As stated above, it is only after a considerable practice that correct designing can be accomplished. It is also true that many of the cases arising in practice can be considered and analyzed without the actual construction by the student, and, by such study, the information obtained from all sources can be more readily classified and digested. The objection may be advanced that information obtained by a study of the character above indicated will not be of value when considering problems of a very different type from those previously investigated. In a degree, this is true, but many factors in all conductor problems are similar, and a thorough analysis of even one conductor problem will necessarily involve the obtaining of a very considerable fund of information which will apply to any case ever arising. A study of a new problem will then show what points of similarity exist between the new and old, and, therefore, what results can be confidently expected, and also what points of dissimilarity exist and upon which judgment must be exercised.

Quite as much information will be obtained in studying the difference between two plants as in studying the points of resemblance. A thorough analysis of any wiring problem consists in a study of the losses in the conductor; the degree to which regulation is affected by the distribution of the losses, which necessitates an intimate knowledge of the method of regulation to be applied; the location of the conductor as to first cost and repairs, its location in such a way as to minimize probability of accidents; and in a study of all the economic questions of the entire station. Nearly all the elements going to make a complete electric light and power plant are variable, with variations in the size of the conductors. A small variation in the size of a conductor will not make much variation in dependent variables, but it is evident that when the question becomes one of magnitude, such as whether, in a given case, ten or twenty or thirty per cent. loss will be most economical, a certain amount of energy being desired at the translating devices, the boiler, engine and dynamo units will all be affected, and the running expenses, particularly as to fuel, will be very different in each case. If, therefore, it is true to a considerable extent for a large variation, then it is also true, to some extent, for a small variation, and, therefore, small amounts can be saved or lost by slight variation in the conductors. As dividends are payable from the difference in income and expense, and as such amount is not always a very large one, it is submitted to the consideration of any interested, whether it would not pay to spend $2,000 to have the wiring of an incandescent plant costing $100,000 properly proportioned if a difference of one per cent. in the dividends thereby resulted; and it is submitted to those who know whether such a difference is within the realm of probability. It is still further submitted that it would be extremely difficult to find either proposed investors or operating companies who would be willing to pay a really competent expert a sufficient amount to enable him to visit the place proposed for the plant and spend a month or more preparing probable ampère output diagrams for each month in the year, studying the local conditions and probable direction of growth, and in other ways incurring an expenditure of time and money, which could only be compensated by a very considerable sum.

The above remarks hold good, even considering only the question of economy of losses; but if the question of regulation of an incandescent lighting plant is considered, they fall far short of the probabilities. It is time that, for any large installation, devices are installed by which variations in voltage are made very small, *provided* the wiring

* The term "conductor" is here used in a limited sense and refers only to the material used to complete the circuit between the generator of electricity and the translating device or devices.

is properly planned: but if the total weight of copper be not distributed to the best advantage, it will not be at all improbable that the bills for lamps will be 10 per cent. more than would otherwise be the case, and this feature alone, aside from all the incident inconveniences and losses due to variation of lights, would make a difference of 1 per cent. annual dividend. This can readily be shown by the following rough estimate:

Consider a plant having 10,000 lamps in place, costing $100,000. Total possible number of hours burning per month of 30 days = 7,200,000 hours. If the ampère diagram shows 10 per cent. of possible number of hours, 720,000 hours represents the total monthly use; and if lamps costing 50 cents and lasting 1,000 hours be the basis taken, 720 lamps, costing $360 per month, will be used.

Tables published by the Edison company show a decrease in life of one-half for an increase of voltage of three per cent. These tables were published some years ago, and the writer presumes that they represented tests made from lamps of the average efficiency then used. Lamps are now run at a greater efficiency, and, therefore, the same percentage variation of voltage makes a greater variation in candle power than in less efficient lamps. However, taking the above figures, it appears that if the lights be all run at three per cent. increase a 3.6 per cent. dividend on the cost of the station will be lost. Evidently this will not often occur in a station running upon a solid basis. It does sometimes occur for competition's sake, and then the lamp manufacturer is liable to suffer, because the lamps will not last, and it is seldom he knows, however much he may suspect, that such is the case.

It is not an improbable case that the increase of potential, at certain places in the circuits and at certain hours, be much more than three per cent. unless the system is carefully planned and *afterward checked and adjusted*. If it amount, as is not unlikely, to three per cent. upon one-half the lamps burning one-half their time, a nine-tenth of one per cent. dividend is lost, and, as hereafter pointed out, *worse than lost*.

To plan and operate a large station and not have greater variation than last indicated is very exceptional. The difficulty of so doing can only be indicated at this point. Suppose a certain feeder has several mains radiating from its point of junction with the same, suppose 2 per cent. drop for average maximum load be calculated for the mains and 3 per cent. (not often realized) for the house wires. Suppose one location to be running on full load and another on one-fourth load. Then if constant "P. D." exists at feeder the lightly loaded circuit will be running high—some parts possibly over 4 per cent. high. Net works, with numerous feeders, for constant current circuits, and converters electrically near to the lamps, and with very small variations of "P. D." at their primaries, for converter circuits, are the methods used to minimize such variations, but they always exist, and often to a great extent. It is a fact that in many stations the lamp bills amount to double what they would if the lamps were never strained.

The statement was above made that the loss of the dividend of .9 per cent. was worse than lost.

The reason why this is a fact is that the loss of dividend resulted from a variation in the candle power of the lamps resulting from the variation of "P. D." Any variation of candle power sufficient to be noticeable can only follow from considerable variation of "P. D.," as the eye does not recognize slight changes. A variation to such an extent means dissatisfaction by the user, as the return to normal brilliancy will seem darkness after operating at 50 to 100 per cent. increase. Straining the lamp for a short time does more injury to the life and to the lowering of "C. P." at normal voltage—due to increased R., blackening of the globe, change of character of radiating surface, etc.—than many hours of burning at normal "P. D.," and customers can not be kept satisfied when the greater number of their lamps are burning dim, and particularly as the fact is usually soon emphasized by the comparatively wonderful brilliancy of a new lamp when inserted to replace some broken one.

To any who, from a consideration of the above, or from previous conviction, believe in the importance of carefully planned wiring the following matter is presented with the hope that the discussion which may result therefrom will prove of value.

(To be continued.)

Curious Cause of Electrical Faults.

The London Electric Supply Company finds that where it uses concentric wires faults suddenly occur. These are found to be due to mice making contact between the earth and the insulated high-pressure terminal. A current passes and blows the fuse, and the burned remains of the mouse are found. Probably mice are attracted by the warmth of the transformers, which, when not too hot, also attract beetles and other insects. When the mice get near the high-pressure terminal there is an electrostatic force which acts on their antennæ. This attracts their attention, and they investigate the terminal and find that, whether knowledge cones after death or not, death is apt to come first. If such calamities occurred in the United States, says our London contemporary *Industries*, the daily press would reek with sensational accounts of the dangers of electricity for months afterward.

The Electromagnet in Eye Surgery.*

BY SILVANUS P. THOMPSON AND J. TATHAM THOMPSON.

For many years past ophthalmic surgeons have used both steel magnets and electromagnets. Indeed, the use of the loadstone has been known for two centuries† for the purpose of extracting from the eyeball chips of iron which have by accident lodged therein, as frequently happens in engineering workshops to fitters and metal turners. Later, in 1745, Dr. Milnes, in his "Observations of Medicine and Surgery," describes how he applied a loadstone to remove a piece of iron from the iris. Probably this was not strictly the case, as he says "immediately it jumped out." It is more likely that he meant that the fragment of iron was embedded in the cornea in front of the iris. According to Hirschberg,‡ Dr. Meyer, of Minden, was, in 1842, the first to use a magnet in extracting fragments of metal from the actual interior of the eyeball.

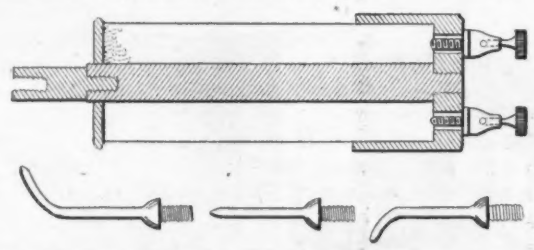
In the middle of this century cases of successful removal were recorded by Critchett,‖ Dixon, White, Cooper and others. There seems to have been little advance until 1874, when Dr. McKeown, of Belfast, recorded in the *British Medical Journal* several successful cases treated by means of a permanent steel magnet tapered at each end to facilitate its introduction.

In 1880, Gruening, of New York, employed a permanent steel magnet composed of a number of "cylinders" (*sic*), united at each end and fitted at one extremity with a needle-shaped pole.

The first use of the electromagnet in this connection is accredited to Hirschberg, of Berlin, in 1877.

In this country, Snell¶ of Sheffield, has been the chief advocate of its use, and in his hands splendid results have been obtained. In the *British Medical Journal* for 1881 he describes his instrument and records the results of several operations. His experiments have steadily progressed since then, and in a recent number of the same journal he brings up the number of his recorded cases to 77.

The thing needed for this special service is an electromagnet which can be fitted with polar appliances of various elongated forms which can be introduced into the wound in the eyeball to a sufficient distance to enable the



Special Electromagnet for Extracting Chips of Iron from the Eyeball.

particle of iron to be attracted and withdrawn. It is necessary at the same time that the electromagnet should not be too heavy to be conveniently held in the hand of the operating surgeon, and that it should be capable of being excited with current from a battery of moderate size, such as an oculist might be expected to be able to manage and maintain without having to call in a skilled electrician at every occasion of its use. It is obvious that, other things being equal, a magnet of considerable projective power is desirable; hence one with a long core, or with an iron expansion at the posterior end of its core, is preferable to a short one. Possibly in some cases the placing of a mass of iron behind the patient's head during the operation might aid the electromagnet to project its magnetic field to the desired depth. Various forms of magnets have been devised by various experimenters.

Snell's instrument, which may be quoted as the typical form commonly used by ophthalmic surgeons in this country, consists of a soft-iron core surrounded by a coil of insulated copper wire inclosed in an ebonite case. At the one extremity are the terminals for the battery connections, and at the other the soft-iron core is tapped to receive the variously shaped and sized needle poles. He recommends the use of a single-quart bichromate cell to generate the current.

Hirschberg's instrument consists of a hollow cylindrical core with two curved pointed poles of different thickness for external and internal use.

Bradford, of Boston, devised an instrument almost identical with Snell's, and simultaneously with the latter. It is, however, a much heavier and more powerful agent.

McHardy, of King's College Hospital, used a very similar instrument, but of much reduced size and weight.

The latest form (see figure) is that brought out by Tatham Thompson, of Cardiff, and is a further modification of Snell's instrument, but for the same weight and bulk additional power is claimed, as the magnetic circuit is perfected by means of a collar of iron continuous with the core projecting forward over the insulated coil toward the manipulative pole piece.

The core is tapped at its extremity to receive the differently shaped poles or an intermediate polar extension where deeper probing is required. The battery used with this consists of one or more quart bichromate "dip" cells. This instrument is shown in the illustration in its actual size, and its weight is only about five ounces.

The most frequent use of the instrument is in removing fragments of steel or iron from the surface or embedded in the coats of the eye, and by its use much disturbance and laceration of the delicate structures is avoided, which the older methods of cutting out or withdrawing by means of forceps, spuds or curettes too often involve. Its most valued properties are, however, best demonstrated where it is used for the removal of foreign bodies which have penetrated the walls of the eye. It is not too much to say that in many cases it has been the only possible means of preserving sight.*

In the first place, it is of diagnostic value, for where a fragment, for instance, has perforated the cornea or anterior transparent part of the eye, it can often be proved whether it is steel or iron by observing whether it is acted on by the close approach of the instrument. If no movement is observed, and no peculiar sensation of dragging pain felt by the patient on the approach of the magnet, it may be due either to its not being a magnetizable metal, or to its being gripped by the tissues, or encysted with inflammatory material thrown out by its irritating presence. If in this case a very lightly suspended needle be magnetized and held close to the eye, it may sometimes be found to dip toward the foreign body. If it should chance to be a steel fragment, this effect is greatly increased by holding the electromagnet close to the eye for a time, so as to magnetize the offending particle.

Further still, the instrument is at times of immense use in moving the fragment from one part of the eye where it is inaccessible, and dropping it in a more favorable position for subsequent removal. For instance, suppose the fragment of steel or iron has penetrated the cornea and lodged in the crystalline lens, it has happened in several cases that by applying the electromagnet to the cornea the metal has been attracted forward through the lens substance, across the aqueous humor contained in the outer chamber of the eye, and then dropped by opening the circuit on to the floor of the outer chamber; then a small opening being made at the most dependent part, the pole of the instrument introduced there, and the fragment readily removed.

In at least one recorded case a sharp pointed fragment, which had penetrated deep into the lens, has been seen to force its way forward through the lens substance and lens capsule, through the iris, and actually be drawn through the cornea, and so removed completely without involving any cutting operation whatever.

It is, however, in those cases where the foreign body has penetrated the posterior or vitreous chamber of the eye that the wonderful results obtained by the electromagnet are best seen. Where only the outer chamber or the lens is the seat of the mischief, other means may possibly succeed; but when a fragment has penetrated the vitreous chamber, we require an instrument not to go blindly searching round, disturbing the delicate structures and risking the escape of the semifluid contents, but one which will attract to itself the offending particle; and this is where the instrument which we are considering reaches its highest achievements.

Many successful cases have been recorded by Snell, Hirschberg, Lloyd Owen, McHardy and others of fragments of steel thus removed from eyes which otherwise must have inevitably been lost.

The most serious and desperate cases of all are where the metal has actually traversed the inner chamber of the eye and become embedded in the delicate retina and choroid lining the posterior wall. So far as can be ascertained, only three successful cases of removal from this position have been recorded. The first by Galezowski in 1882, where a fragment of iron had passed through cornea, iris and lens, and was lodged in the retina. Its position was noted by means of the ophthalmoscope, an instrument employed by ophthalmologists for examining the interior of the eye. An incision was made in the sclerotic or white coat of the eye over the situation, and the fragment removed by means of the electromagnet. The second, recorded by Hirschberg in 1888. The third by Tatham Thompson, of Cardiff, in 1890. Some detailed account of this will illustrate the method of the procedure.

The patient was a blacksmith employed at one of the South Wales collieries, and on Dec. 8, while "stamping" a new "pick," was struck on the left eye by a fragment of the new tool. The fragment struck him on the "sclerotic" or white of the eye, about a quarter of an inch from the margin of the cornea. He felt little pain at the time, but two days later a dull pain supervened, and considerable irritation and dimness of vision, not only in the injured but in the sound eye.

He was sent to the Cardiff Infirmary on Dec. 10. When examined there, a small wound was found at the point where the fragment had entered on the inner side, and on ophthalmoscopic examination, the piece of steel could be seen embedded in the retina at the upper and outer part. The track which it had made in traversing the vitreous chamber could also be distinguished by slight opacities in the humor. The uninjured eye showed distinct signs of sympathetic irritation. The next day the patient was put under the influence of ether, the wound of entrance slightly enlarged to allow the in-

* From *The Electrician*, London.

† Fabricius Hildanus, *Opera observationum et curationum*, Frankfort, 1646. Of this rare work we have not seen a copy.

‡ Hirschberg, *Der Elektro-magnet in der Heilkunde*, Leipzig, 1885.

‖ The *Lancet*, April, 1854, p. 358.

¶ Snell, "The Electromagnet and its Employment in Ophthalmic Surgery", London: Churchill & Co., 1883.

* In addition to references previously given, see Mellinger, *Ueber die Magnet Extractionen an der Basler ophtalmologischen Klinik* (Inaug. Dissert.), Basel, 1887.

troduction of the pole of the electromagnet. This was passed across the vitreous chamber in as nearly as could be calculated the direction originally taken by the fragment. On withdrawing the first time nothing resulted, but at the second attempt the piece of steel came readily through the wound "in tow" of the pole. Only a very small bead of vitreous humor escaped, and the eye was dressed antiseptically and bandaged. At the end of 24 hours he could count fingers at four feet distance, was quite free from pain and dread of light, and the dimness of the other eye had largely disappeared. The wound healed in three days, and the sight steadily improved, till on Dec. 30 he could read moderately sized print. Examined by means of the ophthalmoscope, the scar formed in the retina at the point where the fragment had lodged could be distinctly made out, as well as some patches of hemorrhage caused either by injury from impact of the fragment or by injury of retinal vessels at the time of its removal.

On Jan. 13, 1891, he could read small print; his central vision, in fact, was as good as ever, but his "field of vision" was limited slightly below—the limitation corresponding to the portion of retina injured by the foreign body.

The electromagnet has been used also to some extent in general surgery for the removal of needles from the soft tissues of the body or limbs.

The Riverside Park Electric Railway, at Sioux City.

In THE ELECTRICAL WORLD of June 27 we gave a description of the opening of the Riverside Park Railway line at Sioux City and this week are enabled to present some illustrations that more clearly bring out some of the special features of the road.

The interior of the power-house is shown so clearly as to need no explanation. One part of the road crosses a long trestle at a height of 32 feet above the roadbed of the railway line beneath it. A dozen or more deep cuts found on this line have added greatly to the cost of construction and operation of the line. Some of the curves, too, are very sharp.

Another photograph affords a view of a motor car on the long grade on the old line, while a second motor car is seen on the branch line extending the full length of the park and to a small manufacturing settlement. A view of the Big Sioux River is also obtained through the trees, the stream at this point having a depth of nearly 20 feet and affording excellent fishing, while several boat clubs make the park their headquarters. This stream forms one of the boundary lines of South Dakota.

The knowledge that rapid transit is a certainty and that a reliable service is insured has already had a marked effect on the property values in the section through which the line runs, and President Charles W. Hornick is certainly entitled to all the praise that has been given to him. Fig. 2 shows the construction gang and the apparatus used in building the line. The small steam dummy is attached to two flat cars. On the first car is a large reel of the trolley wire, the wire passing over a wheel placed in a groove at the top of a pole firmly fixed on one of the cars, and nearly as high as the brackets. Any sort of rough braking arrangement applied to the reel insures the wire being drawn as tightly as required. The work was planned and constructed by Mr. B. J. Jones, of the Westinghouse Electric and Manufacturing Company.

This method of constructing a street-railway trolley line must prove as rapid as it is novel, as it will be seen that the minimum amount of labor is needed to erect and fix firmly in place a large amount of trolley line. The method, too, ought to give the best results as regards the tautness of the line and the subsequent need of repairs.

The development of the electric-railway business has been so rapid that much of the work already done has been accomplished without due regard to the economy of the methods employed.

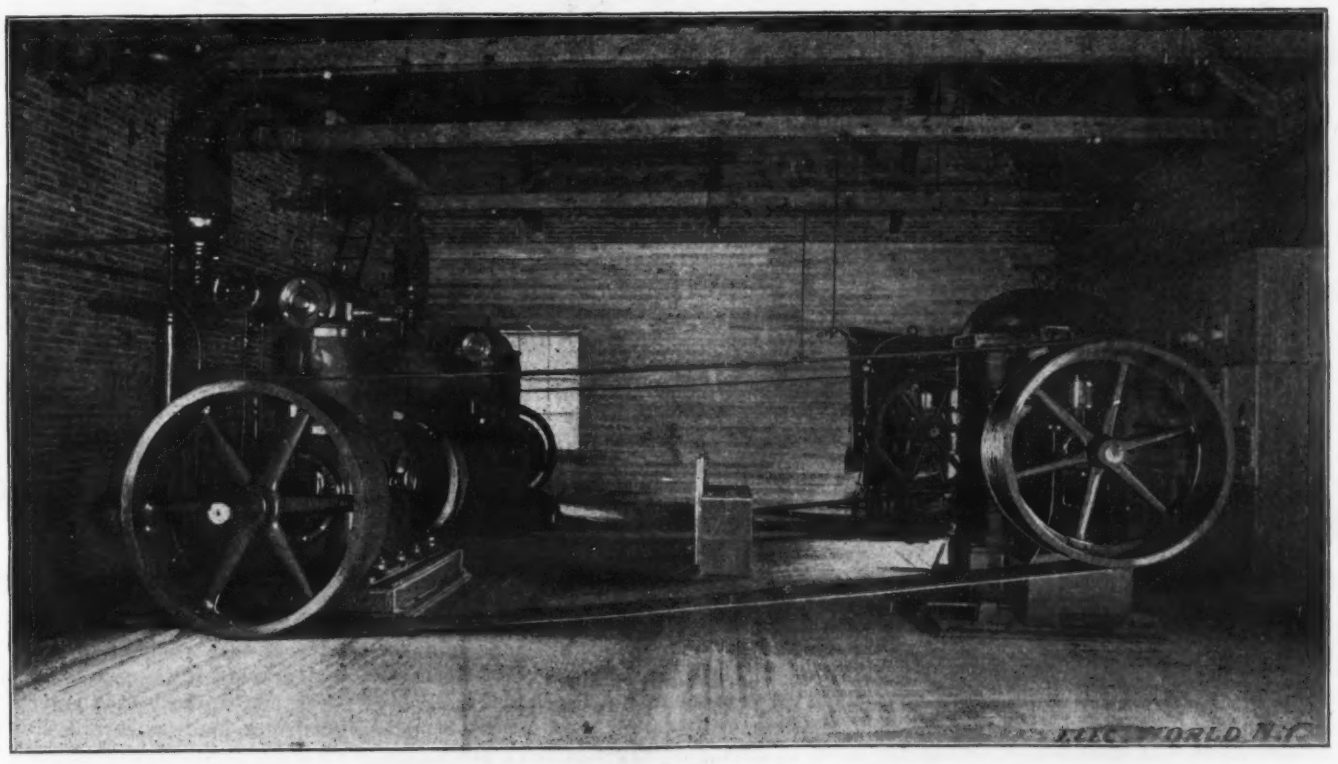


FIG. 1.—GENERATING PLANT OF THE RIVERSIDE PARK ELECTRIC RAILWAY.

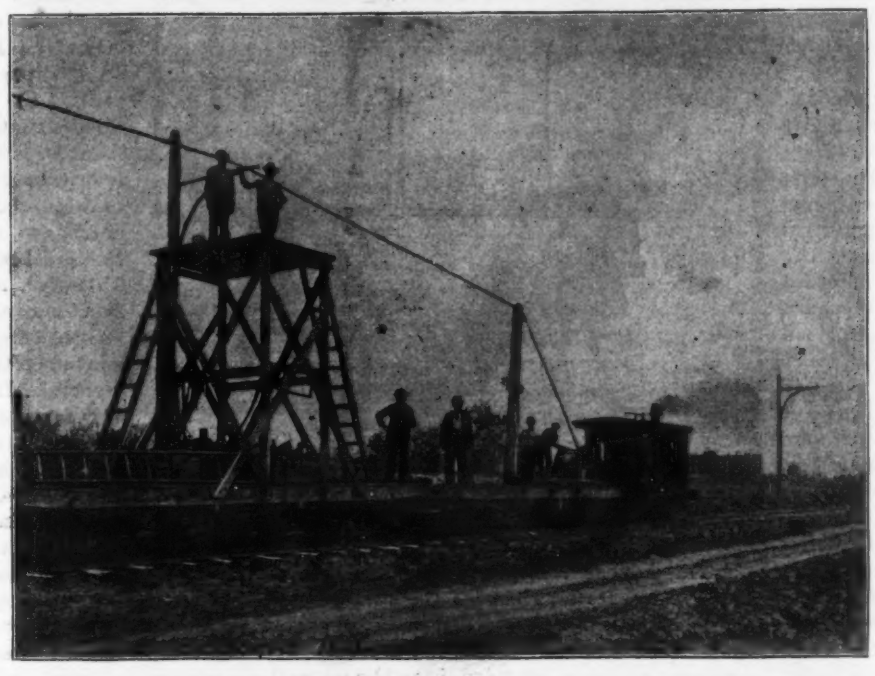


FIG. 2.—CONSTRUCTION OUTFIT OF THE RIVERSIDE PARK ELECTRIC RAILWAY.

(*Copyrighted*, 1890.)

Chronological History of Electricity, Galvanism, Magnetism and the Telegraph, from B. C. 2637 to A. D. 1888.—Part I.*

BY P. F. MOTTELAY.

A. D. 1734.——Swedenborg (Emanuel), founder of the Church of New Jerusalem, details, in his "Principia Rerum Naturalium, etc.," the result of experiments and sets forth the laws relating to magnetic and electric forces and effects. The first explicit treatise upon the close relationship existing between magnetism and electricity was, however, written 14 years later by Mr. Laurent Béraud (1703–1777), professor of mathematics at the College of Lyons. Both Swedenborg and Béraud recognized the fact that it is, as Fahie expresses it, the same force, only differently disposed, which produces both electric and magnetic phenomena.

See Béraud "Dissertation, etc.," Bordeaux, 1748: also Priestley, "History," etc., London, 1775, p. 191, and "Biographie Universelle," vol. III., p. 687.

A. D. 1735–1746.——Ulloa (Don Antonio de), Spanish mathematician, who left Cadiz May 26, 1735, for South America, whither he was sent with Condamine and other French academicians, as well as with Spanish scientists, to measure a degree of the meridian, returned to Madrid July 25, 1746, and shortly after gave an account of his experiences during an absence of 11 years and two months.

In his "Voyage Historique de l'Amérique Méridionale," Amsterdam and Leipsic, 1752, he speaks (vol. I., pp. 14–18, and vol. II., pp. 30–31, 92–94, 113, 123, 128) of the defective magnetic needles given him as well as of the means of correcting them, and he details at great length the variations of the needle observed during the voyage. He also alludes to the variation charts of Dr. Halley and to the alterations therein made by advice of William Mountaine and Jacob Dooson, of London, as well as to the methods of ascertaining the variation of the magnetic needle pointed out both by Manuël de Figueyredo, at chap. IX. to X. of his "Hidrographie ou Examen des Pilotes," printed at Lisbon in 1608, and by Don Lazare de Flores at chap. I., part 2, of his "Art de Naviguer," printed in 1672. The latter, he says, asserts, in chap. IX., that the Portuguese find his method so reliable that they embody it in all the instructions given for the navigation of their vessels.

At pp. 66, 67, chap. X. of vol. II., Ulloa makes the earliest recorded reference to the *aurora australis*, as follows: "At half-past ten in the evening, and as we stood about two leagues from the island of *Tierra de Juan Fernandez*, we observed upon the summit of a neighboring mountain a very brilliant and extraordinary light. . . . I saw it very distinctly from its inception, and I noticed that it was very small at first, and gradually extended until it looked like a large, lighted torch. This lasted three or four minutes, when the light began to diminish as gradually as it had grown, and finally disappeared."

Incidentally, it may be stated here that the very learned Dr. John Dalton reported having seen the *aurora australis* in England, and to have observed the *aurora borealis* as far as 45° latitude south (see accounts in *Philosophical Transactions*, *Philosophical Magazine*, *Manchester Transactions* and *Nicholson's Journal*) while De Humboldt remarks ("Cosmos," 184-, vol. I., p. 192, note) that "in south polar bands, composed of very delicate clouds, observed by Arago, at Paris, on the 23d of June, 1844, dark rays shot upward from an arch running east and west, and that he had already made mention of black rays resembling dark smoke as occurring in brilliant nocturnal northern lights."

See reference to *aurora australis* made by the naturalist John Reinhold Forster, in the article on "Aurora Borealis" of the "Encyc. Britannica."

A. D. 1738.——Boze (G. M.), professor of philosophy at Wittemburg, publishes his "Oratio inauguralis de electricitate," which is followed, in 1746, by "Recherches sur la cause et sur la véritable théorie de l'électricité," and, in 1747, by his "Tentamina electrica."

To him is due the introduction in the electrical machine of the prime conductor, in the form of an iron tube or cylinder, which latter was at first supported by a man insulated upon cakes of resin and afterward suspended by silken strings. Mr. Boze discovered that capillary tubes discharging water by drops gave a continuous run when electrified. He also conveyed electricity by a jet of water from one man to another, standing upon cakes of resin, at a distance of six paces, and likewise employed the jet for igniting alcohol and other liquids.

See Alglave et Boulard, 1882, p. 22, also Priestley, 1775, upon "Miscellaneous Discoveries," *Phil. Trans.* for 1745, vol. XLIII., p. 419, and for 1749, vol. XLVI., p. 189.

A. D. 1739.——Desaguliers (J. F.), chaplain to his Grace the Duke of Chandos, gives an account of his first experiments on the phenomena of electricity at pp. 186, 193, 196, 198, 200, 209, 634, 637, 638 and 661 of vol. XLI of the *Phil. Trans.* for 1739. Some of these experiments were made on the 15th of April, 1738, at H. R. H. the Prince of Wales' house at Cliefden.

He was the first to divide bodies into "electrics," or non-conductors, and "non-electrics," or conductors. He ranked pure *air* amongst his electrics (Tyndall, Lecture I.) and stated that "cold air in frosty weather, when vapors rise least of all, is preferable for electrical purposes to warm air in summer, when the heat raises the vapors." (*Phil. Trans.*, abridged, vol. VIII., p. 437.) It was Desaguliers who announced that he could render bars of iron magnetic, either by striking them sharply against the ground while in a vertical position or by striking them with a hammer when placed at right angles to the magnetic meridian.

His "Dissertation Concerning Electricity," London, 1742, is said to be the second work on the subject published in the English language, the first having been Boyle's "Mechanical Origine or Production of Electricity" A. D. 1675.

* Continued from THE ELECTRICAL WORLD, July 11, 1891.

Desaguliers was the second to receive the Copley medal, it having been previously bestowed by the Royal Society only upon Stephen Grey, who obtained it in 1731 and 1732 for his "New Electrical Experiments." The list of recipients of this distinguished honor, given by C. R. Weld at page 385, vol. I., of the "History of the Royal Society," shows that Desaguliers is the only one to have ever received *three* of these medals; these were awarded him during the years 1734, 1736 and 1741, for his "Experiments in Natural Philosophy." John Canton was given two of the medals, in 1751 and 1765, the only other electrician similarly favored being Michael Faraday, who received them during the years 1832 and 1838, while Sir Humphrey Davy is credited with only one, conferred upon him in 1805.

See *Phil. Trans.* for 1742, vol. XLII., pp. 14, 140; Thomson, "Hist. Roy. Soc.," 1812, pp. 433, 434.

A. D. 1740.——Celsius (Anders), who filled the chair of astronomy at Upsal, is first to point out the great utility of making simultaneous observations over a large extent of territory and at widely different points. He states (*Svenska Vetenskaps Academieus Handlingar* for 1740, p. 44) that a simultaneity in certain extraordinary perturbations, which had caused a horary influence on the course of the magnetic needle at Upsal and at London, afforded proof "that the cause of these disturbances is extended over considerable portions of the earth's surface, and is not dependent upon accidental local actions."

In the following year (1741), Olav Hiörter, who was Celsius' assistant, discovered and measured the influence of polar light on magnetic variation. His observations were subsequently carried on in conjunction with Celsius, and were improved upon by Wargentin (A. D. 1750) and by Cassini (A. D. 1782—1791).

See Walker, "Ter. and Cos. Magnetism," p. 116; also De Humboldt, "Cosmos," *re* "Magnetic Disturbances," and vol. II., page 438, of Weld's "History of the Royal Society."

A. D. 1742.——Gordon (P.), a Scotch Benedictine monk, professor of philosophy at Erfurt, abandons the use of globes and is the first to employ a glass cylinder, the better to develop electricity. His cylinder, eight inches long and four inches wide, is made to turn by means of a bow with such rapidity that it attains 680 revolutions per minute.

Priestley says ("Discovery of Germans," part I., period VII.) that Gordon "increased the electric sparks to such a degree that they were felt from a man's head to his foot, so that a person could hardly take them without falling down with giddiness; and small birds were killed by them. This he effected by conveying electricity, with iron wires, to the distance of 200 ells (about 250 yards) from the place of excitation."

See *Dantzik Memoirs*, vol. II., pp. 358, 359, and Nollet, "Recherches, etc.," p. 172.

A. D. 1743.——Hausen (Christian Augustus), professor of mathematics at Leipsic, publishes his "Novi profectus in historia electricitatis," and is the first to revive the use of the glass globe introduced by Newton (A. D. 1675) and employed notably by Hauksbee (A. D. 1705).

In the annexed curious illustration, Fig. 1, taken from Watson's "Expériences et observations sur l'électricité," is shown an electrical machine constructed by Hausen and differing but slightly from the one alluded to at A. D. 1705 as made for Mr. Wolfius. As will be observed, a lady is pressing her hand against the glass globe, which is being rotated rapidly, thus developing upon its surface the vitreous electricity, while the resinous electricity passes through her body to the earth. The young man who is suspended and insulated by silken cords, represents the prime conductor introduced by Prof. Boze (A. D. 1738). The vitreous electricity passes from the surface of the glass globe, through his feet and entire body, and is communicated by his hand to the young girl, who stands upon a large section of rosin, and is able to attract small parcels of gold leaf by means of the electric fluid.

Fig. 2 illustrates another machine, taken from the same French work, originally published at Paris in 1748, and therein said to be at that time much in use throughout Holland and principally at Amsterdam. The man at *B* rotates the glass globe *C*, against which latter the operator at *D* presses his hand, and the electricity is conveyed through the metallic rod supported by silk covered stands and held by a third party, *G*, who is igniting spirits in the manner indicated at the A. D. 1744 date.

See *Dantzik Memoirs*, vol. I., pp. 278, 279.

A. D. 1743.—Boerhaave—Boerhaaven—(Hermann), page 70B, illustrious physician, mathematician and natural philosopher, who held the chairs of theoretical medicine, practical medicine, botany and chemistry at the University of Leyden, F. R. S. and member French Academy of Sciences, writes an Essay on the virtue of Magnetical Cure, of which there were subsequently many additions and translations in different languages.

One of his biographers calls him "the Galen, the Ebn Sina, the Fernel of his age." Another remarks that he was, perhaps, the greatest physician of modern times: "A man who, when we contemplate his genius, his erudition, the singular variety of his talents, his unfeigned piety, his spotless character, and the impress which he left not only on

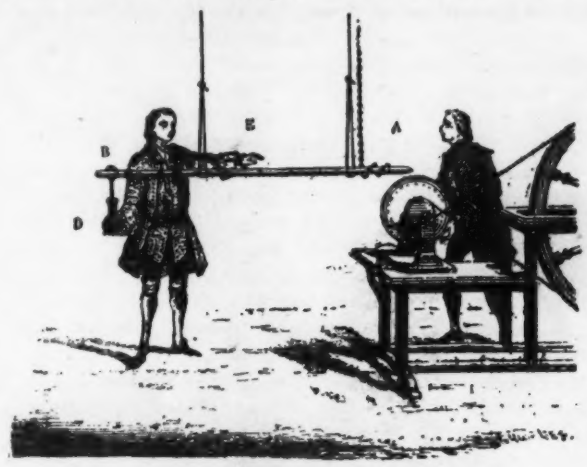


Fig. 3.—Musschenbroeck's Experiment.

contemporaneous practice, but on that of succeeding generations, stands forth as one of the brightest names on the page of medical history, and may be quoted as an example not only to physicians, but to mankind at large. No professor was ever attended, in public as well as private lectures, by so great a number of students, from such distant and different parts, for so many years successively; none heard him without conceiving a veneration for his person, at the same time that they expressed their surprise at his prodigious attainments; and it may be justly affirmed, that none in so private a station ever attracted a more universal esteem.

See: "Biographica Philosophica," Benj. Martin, London, 1764, pp. 478-483; "Eloge de Boerhaave," by Maty, Leyde, 1747, and by Fontenelle, 1763, T. VI.; his life, written by Dr. Wm. Burton, London, 1736; Van Swinden, "Recueil, etc.," La Haye, 1784, vol. II., p. 354, note: "La Grande Encyclopédie," Tome VII., p. 42; "Biographie Générale," Tome VI., pp. 352-357; "Biographie Universelle," vol. IV., pp. 529-555; Ninth "Encycl. Britannica," vol. III., p. 854.

A. D. 1744.——Ludolf (Leudolf), of Berlin, first exhibits, Jan. 23, the ignition of inflammable substances by the electric spark. This he does in the presence of hundreds of spectators, on the occasion of the opening of the Royal Academy of Sciences by Frederick the Great of Prussia, when fire is set to sulphuric ether through a spark from the sword of one of the court cavaliers. (See Notes on Tyndall's second lecture.)

It was likewise at this period Ludolf the younger demonstrated that the luminous barometer is made perfectly electrical by the motion of the quicksilver, first attracting and then repelling bits of paper, etc., suspended by the side of the tube, when it was inclosed in another out of which the air was extracted.

See *Dantzik Memoirs*, vol. III., p. 495.

A. D. 1744–1745.—Waitz (Jacob Siegismund von), a German electrician, writes three essays in Dutch and one in French, and is given the prize of fifty ducats proposed by the Berlin Academy of Sciences for the best dissertation on the subject of electricity. In the following year he makes experiments, with M. Du Tour, to show the destruction of electricity by flame, and later on with Prof. Hamberger he proves conclusively that the motion of quicksilver in a glass vessel out of which the air is extracted has the power of moving light bodies. Jean Nicolas Sebastian Allamand subsequently found that it was immaterial whether the vessel had air in it or not.

See Tyndall's Notes on Lecture II., also *Dantzik Memoirs*, vol. II., pp. 380, 426, and Mr. Du Tour's "Recherches sur les Différents Mouvements de la Maitère Electrique," Paris, 1760.

A. D. 1745.——Kratzenstein (C. G.), professor of medicine at Halle, author of "Versuch einer Erklarung, etc.," and of "Theoria Electricitatis," etc., is said to have first successfully employed electricity in the relief of sprains, malformations, etc. He observed that a man's pulse, which had beat eighty in a second before he was electrified, immediately after beat eighty-eight, and was presently increased to ninety-six.

Kratzenstein is said (Mary Somerville, "Physical Sciences," Section XVII.) to have made instruments which articulated many letters, words and even sentences, and similar in construction to those manufactured by Wolfgang Von Kempelen, alluded to under date A. D. 1254 (See Whewell, "History of the Inductive Sciences," vol. II., chap. VI.) All such contrivances as these, as well as those alluded to at A. D. 1254 (Albertus Magnus and Roger Bacon), at A. D. 1620 (De Bergerac), and A. D. 1641 (John Wilkins), strongly suggest the modern phonograph. Two more curious productions, in pretty much the same line as Bergerac's, can, with equal propriety, be inserted here. The first is taken from the April number, 1632, of the *Courier Véritable*, a little monthly publication in which novel fancies were frequently aired: "Captain Vosterloch has returned from his voyage to the southern lands, which he started on two years and a half ago, by order of the States-General. He tells us, among other things, that in passing through a strait below Magellan's, he landed in a country where Nature has furnished men with a kind of sponge which holds sounds and articulations as our sponges hold liquids. So, when they wish to dispatch a message to a distance, they speak to one of the sponges, and then send it to their friends. They, receiving the sponges, take them up gently and press out the words that have been spoken into them, and learn by this admirable means all that their correspondents desire them to know."

The second is the production of one Thomas Ward, theological poet, who was born in 1640 and died in 1704. In the second canto of one of his poems occur these words:

"As Walchius could words imprison
In hollow canes so they, by reason,
Judgment and great dexterity,
Can bottle words as well as he;
And can from place to place convey them,
Till, when they please, the *reed* shall say them:
Will suddenly the same discharge,
And hail-shot syllables at large
Will fly intelligibly out
Into the ears of all about:
So that the *auditors* may gain
Their meaning from the breach of cane."

See Priestley, "History, etc.," 1775, p. 374, and *Dantzik Memoirs*, vol. I., p. 294.

A. D. 1745.——Grummert (Gottfried Heinrich), of Biala, Poland, first observes the return of the electric light *in vacuo*. In order to ascertain whether an exhausted tube would give light when it was electrified, as well as when it was excited, he presented one eight inches long and a third of an inch wide, to the electrified conductor, and was surprised to find the light dart very vividly along the entire length of the tube. He likewise observed that some time after the tube had been presented to the conductor, and exposed to nothing but the air, it gave light again without being brought to an electrified body. (See *Dantzik Memoirs*, vol. I., p. 417.)

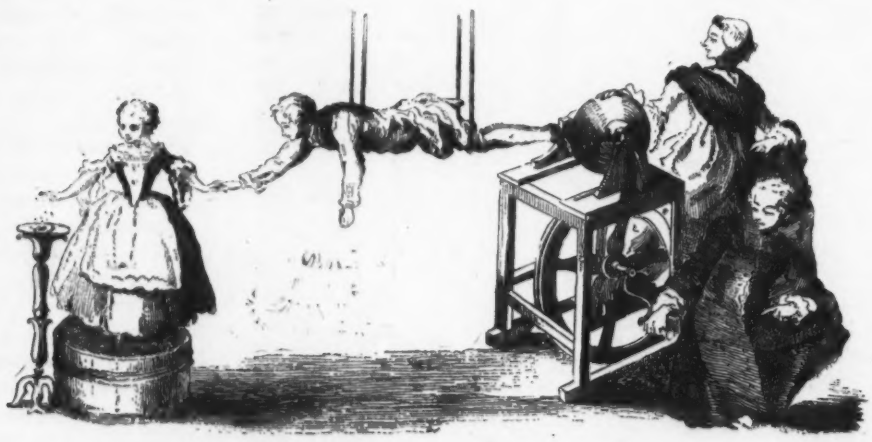


FIG. 1.—HAUSEN'S ELECTRICAL MACHINE.

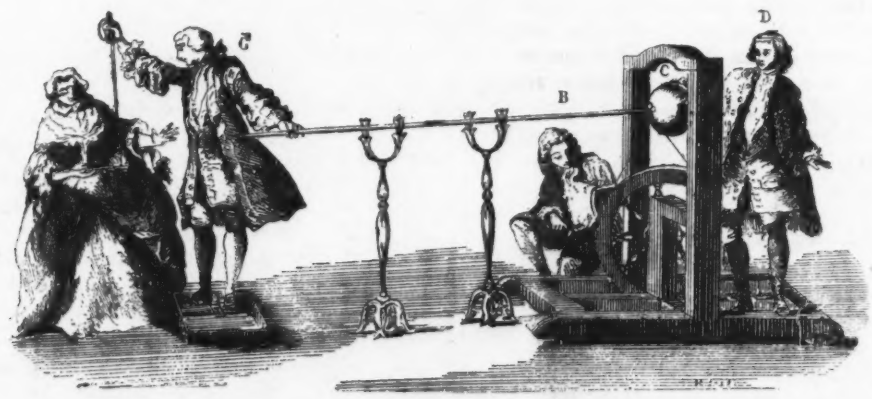


FIG. 2.—ELECTRICAL MACHINE USED THROUGHOUT HOLLAND.

A. D. 1745.——Dr. Miles reads, March 7th, before the English Royal Society a paper indicating the possibility of kindling phosphorus by applying to it an excited electric without the approach of a conducting body. This gentleman's tube happening to be in excellent order upon this occasion, he observed, and doubtless was the first to notice, *pencils of luminous rays*, which he called *corruscations*, darting from the tube without the aid of any conductor approaching it.

In a paper which Dr. Miles read before the same Society on the 25th of January, 1746, he gave an account of other equally interesting experiments, one of which was the kindling of ordinary lamp spirits with a piece of black sealing wax excited by dry flannel or white and brown paper. (See *Phil. Trans.* for 1744, vol. XLIII., p. 290, and vol. X., abridged pp. 272, 320.)

A. D. 1745.——This period was to witness a discovery which, according to Professor Tyndall, "*throws all former ones in the shade*," and which Dr. Priestley calls "*the*

most surprising yet made in the whole business of electricity." This was the accumulation of the electric power in a glass phial, called the Leyden Jar after the name of the place where the discovery was made. It was first announced in a letter to Von Kleist, dean of the cathedral of Kamin in Pomerania, dated the 4th of November, 1745, and addressed to Dr. Lieberkühn, who communicated it to the Berlin Academy. The following is an extract: "When a nail or a piece of thick brass wire is put into a small apothecary's phial and electrified, remarkable effects follow; but the phial must be very dry,

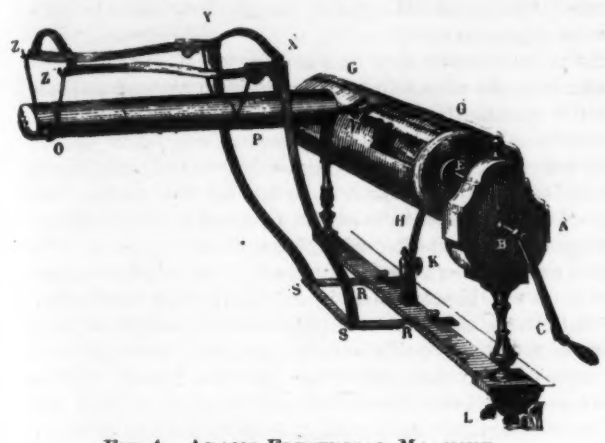
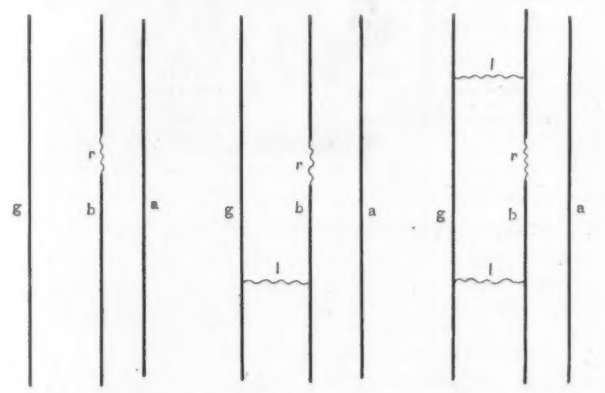


FIG. 4.—ADAMS ELECTRICAL MACHINE.

or warm; I commonly rub it over beforehand with a finger, on which I put some pounded chalk. If a little mercury, or a few drops of spirit of wine, be put into it, the experiment succeeds the better. As soon as this phial and nail are removed from the electrifying glass, or the prime conductor to which it has been exposed is taken away, it throws out a pencil of flame so long that, with this burning machine in my hand, I have taken above sixty steps in walking about my room; when it is electrified strongly I can take it into another room and there fire spirits of wine with it. If while it is electrifying I put my finger, or a piece of gold which I hold in my hand, to the nail, I receive a shock which stuns my arms and shoulders."

It is said that Cunæus, rich burgess of Leyden, accidentally made the discovery in January, 1746. It appears that Pieter Van Musschenbroeck, the celebrated professor, while experimenting with his colleagues, Cunæus and Allamand, observed that excited bodies soon lost their electricity in the open air, which was attributed to the vapors and effluvia carried in the atmosphere, and he conceived the idea that the electricity might be retained by surrounding the excited bodies with others that did not conduct electricity. For this purpose he chose water, the most readily procured non-electric, and placed some in a glass bottle. No important results were obtained until Cunæus, who was holding the glass bottle containing the water they were electrifying, attempted to withdraw the wire which connected with the conductor of a powerful electric machine. He at once received a severe shock in his arms and breast, as did also the others upon renewing the experiment. In giving an account of it to the great scientist, René de Réaumur, Musschenbroeck says: "For the whole kingdom of France, I would not take a second shock."



FIGS. 11, 12 AND 13.—ELECTRICAL CABLE TESTING.

Allamand states that when he took the shock "he lost the use of his breath for some minutes, and then felt so intense a pain along his right arm that he feared permanent injury from it."

The experiment just alluded to is illustrated in the accompanying figure. Musschenbroeck is therein shown as holding the glass bottle *D* and is in the act of drawing sparks from the iron rod *A B*, which is suspended by silken cords and receives the electricity from the glass globe against which Dean Von Kleist is pressing his hands. ("Mémoires de mathématique . . . de l'Académie Royale des Sciences de Paris pour 1746," page 2.) In his "Corvs Elémentaire de Physique." Musschenbroeck describes one of the peculiar electrical machines then being constructed by the well-known London instrument maker, George Adams, and a cut of which can be seen at page 353. vol. I, of of the translation made by Sigaud de la Fond at Paris during 1769. Another of Adams' machines is described and illustrated at page 126 of the French translation of Cavallo's "Complete Treatise," published at Paris in 1785.

Electrical Cable Testing.—IV.

BY HENRY W. FISHER.

Fig. 11 shows the open wire with a leak *r* at the break If such a wire is charged from one end, part of the charge will leak through at the break and partially charge the other end of broken wire, and when the discharging key is released there will be a return discharge from the other end which will make the throw as read greater than the true throw for the near section of the broken wire. The amount of increase depends not only upon the resistance at the break, but also upon the time of vibration of the galvanometer, and upon the length of time the cable was charged. The writer found that even through a resistance of 50 megohms the true throw was slightly increased, while for a resistance of 1 megohm the throw as read was nearly equal to the sum of the deflections due to the capacities at opposite sides of the resistance.

The simplest way to treat this case is to ground the distant end of the open wire and then apply the methods just given in the last two cases to the near end of the wire. Then if a good wire is accessible connect it to the other end of the open wire and ground the near end, after which apply the correction tests and formula 15 to get the true throw due to the good wire and distant open end. Then calculate the distance to the break as has been previously shown. It should be understood that any of the formulæ (12, 13 and 14) can be used in these special cases as soon as the true throws have been calculated.

In order to read the true throw directly without the use of a condenser the writer prepared the following method:

Fig. 14 shows the general arrangement. For the sake of clearness a side view of the discharging key is given.

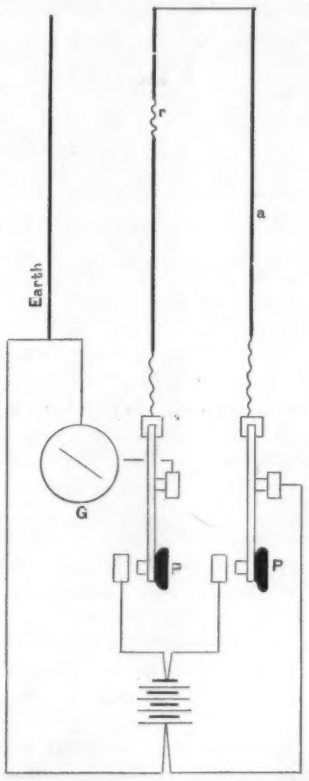


FIG. 14.—ELECTRICAL CABLE TESTING.

It will be noticed that the connections to the discharging key are such that on pressing down the buttons *P P*, one key charges the near end of the open wire, while the other charges the distant end through the good wire *a*. When the keys are released the charge on the distant end is short-circuited, while that on the near end passes through the galvanometer and gives the true throw. Similarly, by reversing the connections the true throw for the distant end can be obtained. The buttons *P P* must be released simultaneously. If difficulty is experienced in doing this, they should be connected rigidly by a piece of hard rubber, with one central button upon it, and then by proper adjustment of the contact points good results can be obtained.

The remaining two cases (Figs. 12 and 13) show leaks on one end and on both ends of the broken wire, respectively.

The general method for solving these is to ground the end of the open wire not under test and apply the correction method to the other end, and as soon as both corrected throws are obtained calculate the distance to the break.

SUPPLEMENTARY REMARKS.

There are a few special formulæ which the writer has worked out and used, and some of these will now be given.

In locating grounds and crosses it is not always convenient to have lead wires of the same resistance. Moreover, if there is any doubt as to whether these wires have the same resistance, the resistance of each should be measured either separately or by a method that will be given later.

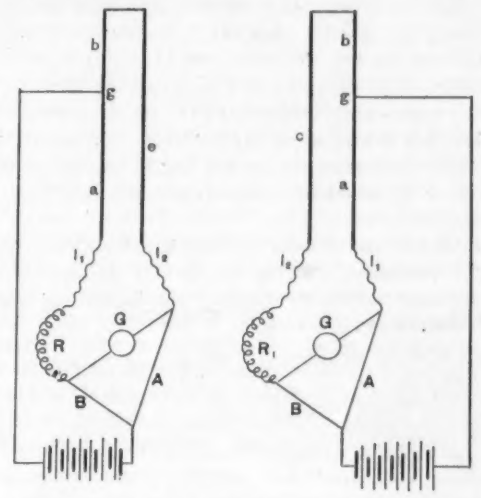
In Figs. 15 and 16 it will be noticed that the general connections are the same as have been given before, but the lead wires are marked l and l_2 respectively. Under these conditions formulæ 2 and 7 become

$$a = \frac{B(d + c + l_2) - A(l_1 + R)}{A + B} \qquad (16)$$

and formulæ 3 and 18 become

$$a = \frac{A(d + c + l_2 + R_1) - B l_1}{A + B} \qquad (17)$$

On one occasion the writer had to use two air lines running to a cable box for lead wires. These were practically the same length and size, and, as no third wire was accessible to determine the exact resistance of each lead wire, the resistance of the two of them connected together at the pole box was measured, and half of this was taken as the value of l. The subsequent calculation gave a greater resistance to the fault than that of the faulty wire; and this inconsistency was explained by the fact that the respective resistances of the lead wires were not the same.



FIGS. 15 AND 16.—ELECTRICAL CABLE TESTING.

To obtain these resistances the following method was adopted:

After making the tests shown in Figs 15 and 16 to determine R and R_1, the connections of the lead wires were reversed at the pole box as shown in Figs 17 and 18, and R_{II} and R_{III} were determined in a manner similar to that used in getting R and R_1. From this data and the combined measured resistance of the lead wires which we will call L two check formulæ giving the separate resistances of l_1 and l_2 were marked out. These are

$$l_1 = \tfrac{1}{2} L + \frac{A(R_{II} - R)}{2(A + B)} \text{ or } l_1 = \tfrac{1}{2} L + \frac{A(R_1 - R_{III})}{2(A + B)} \qquad (18)$$

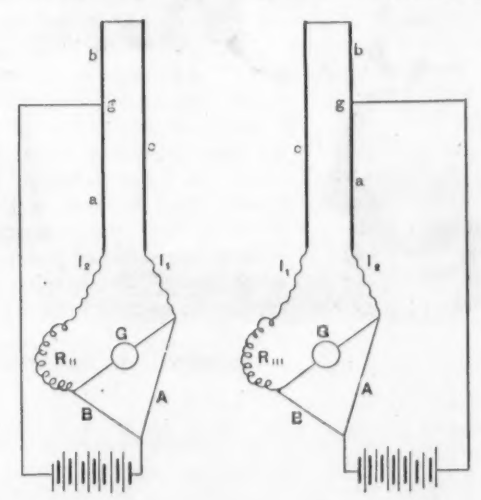
$$l_2 = \tfrac{1}{2} L - \frac{A(R_{II} - R)}{2(A + B)} \text{ or } l_2 = \tfrac{1}{2} L - \frac{A(R_1 - R_{III})}{2(A + B)} \qquad (19)$$

For the case just given the values of l_1 and l_2 differed considerably, and when their values were substituted in formulæ 16 and 17 the location of the ground as finally calculated was within a few feet of where the fault was discovered.

While the above formulæ were being worked out a third wire was run to the pole box, and the resistances of l_1 to l_2 as calculated by formulæ 1 agreed exactly with those obtained by formulæ 18 and 19.

These formulæ will often be of use. It is hardly necessary to calculate the values of l_1 and l_2 twice, but both equations are given for general convenience.

The statement was made under "Locating Grounds" that R is always greater than R_1. This is not necessarily so, if



FIGS. 17 AND 18.—ELECTRICAL CABLE TESTING.

the lead wires have different resistances; hence, before making the measurements, all the wires should be identified and tagged.

Under "Open Wires" the statement was made that breaks can be located quite accurately if the insulation resistance of the open wire is at least ten megohms and if the resistance of the break is at least 50 megohms. If the insulation resistance of one section of the open wire tests very high while that of the other section is low, the resistance of the break must necessarily be high; but if both insulation resistances are low the resistance of the break may either be high or low, and hence the insulation resistance as measured may either be right or may be lower than the true insulation of the section under test.

In order to determine definitely, therefore, whether the measurements can be made without applying the correction formula, three equations based on three measurements have been worked out.

These measurements are as follows:

1st. Measure the insulation resistance of the near section of the open wire.

2d. Measure the insulation resistance of the distant section and a good wire by connecting it to the latter.

3d. Connect both ends of the open wire to both ends of the good wire and measure the insulation resistance of the combination.

Letting r, s, t stand for these measurements respectively, and letting a = the true insulation resistance of the near section, and letting b = the true insulation resistance of the good wire and far section, and letting c = the resistance of the break, then

$$a = \frac{2rts}{ts + rs - rt} \qquad (20)$$

$$b = \frac{2rts}{rs + rt - st} \qquad (21)$$

$$c = \frac{2rts}{rt + st - rs} \qquad (22)$$

Formula (22) is the most valuable of these, and having determined by it the resistance of the break, we are at once in a position to know whether or not the correction formula must be applied.

Theoretically it would seem that the break ought to have a very high resistance, but on account of disruptive discharges that may partially carbonize the insulating material this is not always the case.

[Errata.—In THE ELECTRICAL WORLD of July 4, in the second part of the above article, formula (3) should have the minus sign before the Bl instead of that of equality; and under example 2d, second method, + 1000 × .037 should read − 1000 × .037.]

Electrical Evapora'io .*

BY PROF. WM. CROOKES.

Finding the cadmium volatilized so readily under the action of the induction current, a large quantity, about 350 grains, of the pure metal was sealed up in a tube, arranged

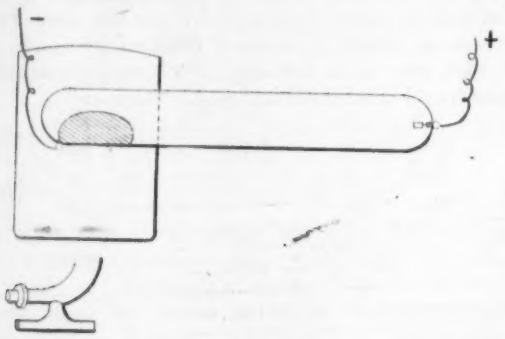


FIG. 8.—CROOKES' EXPERIMENTS ON ELECTRICAL EVAPORATION.

as in Fig. 8, and the end of the tube containing the metal was heated to a little above the melting point, the molten metal being made the negative pole. In a few hours the whole quantity had volatilized and condensed in a thick layer on the far end of the tube, near, but not touching, the positive pole.

Volatilization of Silver.—Silver was the next metal experimented upon. The apparatus was similar to that used for the cadmium experiments (Fig. 7). Small lumps of pure silver were cast on the ends of platinum wires, and suspended to the inner ends of platinum terminals passing through the glass bulb. The platinum wires were protected by glass, so that only the silver balls were exposed. The whole apparatus was inclosed in a metal box lined with mica, and the temperature was kept as high as the glass would allow without softening. The apparatus was exhausted to a dark space of three millimetres, and the current was kept on for one and a half hours. The weights of silver, before and after the experiment, were as follows:

	Positive pole.	Negative pole.
Original weight of silver	18.14 grs.	24.63 grs.
Weight after the experiment	18.13 "	24.44 "
Silver volatilized in 1½ hours	0.01 "	1.19 "

It having been found that silver volatilized readily from the negative pole in a good vacuum, experiments were instituted to ascertain whether the molecules of metal shot off from the pole were instrumental in producing phosphorescence. A glass apparatus was made as shown in Fig. 9. A pear-shaped bulb of German glass has, near the small end, an inner concave negative pole, A, of pure silver, so mounted that its inverted image is thrown upon the opposite end of the tube. In front of the pole is a screen of mica, having a small hole in the centre, so that only a narrow pencil of rays from the silver pole can pass through, forming a bright spot of phosphorescence, D, at the far end of the bulb. The exhaustion was pushed to a high point, 0.00068 millimetres, or 0.9 metre. The current from an induction coil was allowed to pass continuously for some hours, the silver pole being kept negative, so as to drive off a certain portion of the silver electrode. On subsequent examination it was found that the silver had all been deposited in the immediate neighborhood of the pole, while at the far end of the tube the spot D, that had been continuously glowing with phosphorescent light, was practically free from silver.

A tube was next made as shown in Fig. 10. It had two negative poles connected together, A, A', so placed as to

*A paper read before the Royal Society of London; continued from THE ELECTRICAL WORLD, July 11, 1891.

project two luminous spots on the phosphorescent glass of the tube. One of the electrodes, A', was of silver, a volatile metal; the other, A, was of aluminium, practically non-volatile. On connecting the two negative poles, A, A', with one terminal of the coil, and the positive pole, B, with the other terminal, it was seen in the course of half an hour that a considerable quantity of metal had been projected from the silver negative pole, blackening the tube in its neighborhood, while no projection of metallic particles took place from the aluminium positive pole. During the whole time of the experiment, however, the two patches of phosphorescent light, C and C', had been glowing with

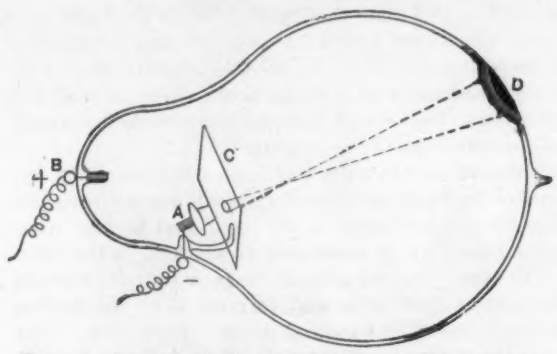


FIG. 9.—CROOKES' EXPERIMENTS ON ELECTRICAL EVAPORATION.

exactly the same intensity, showing that the active agent in effecting phosphorescence was not the molecules of the solid projected from the poles, but the residual gaseous particles, or "radiant matter."

In the tubes hitherto made containing silver, it had not been easy to observe the spectrum of the negative pole, owing to the rapid manner in which the deposit obscured the glass. A special tube (Fig. 11) was therefore devised, of the following character: The silver pole, A, was attached to the platinum pole at one end of the tube, and the aluminium positive pole, B, was at the side. The end of the tube opposite the silver pole was rounded, and the spectroscope was arranged to observe the light of the volatilizing silver "end on," as shown in the figure. In this way the deposit of silver offered no obstruction to the light, as none was deposited except on the sides of the tube surrounding the silver. At a vacuum giving a dark space of about three millimetres from the silver a greenish-white glow was seen to surround the metal. This glow gave a very brilliant spectrum. The spark from silver poles in air was brought into the same field of view as the vacuum glow, by means of a right-angled prism attached to the spectroscope, and the two spectra were compared. The two strong green lines of silver were visible in each spectrum; the measurements taken of their wave-lengths were 3,344 and 3,675, numbers which are so close to Thalén's numbers as to leave no doubt that they are silver lines. At a pressure giving a dark space of 2 millimetres the spectrum was very bright, and consisted chiefly of the two green lines and the red and green hydrogen lines. The intercalation of a Leyden jar into the circuit does not materially increase the brilliancy of the lines, but it brings out the well-known air lines. At this pressure not much silver flies off from the pole. At a higher vacuum, the luminosity round the silver pole gets less and the green lines vanish. At an exhaustion of about one-millionth of

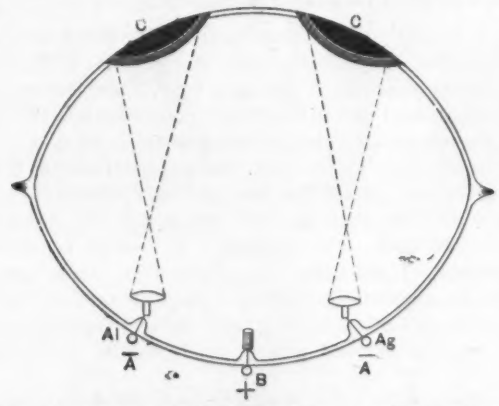


FIG. 10.—CROOKES' EXPERIMENTS ON ELECTRICAL EVAPORATION.

an atmosphere the luminosity is feeble, the silver pole has exactly the appearance of being red hot, and the volatilization of the metal proceeds rapidly.*

If, for the negative electrode, instead of a pure metal such as cadmium or silver, an alloy was used, the different components might be shot off at different distances, and in this way make an electrical separation—a sort of fractional distillation. A negative terminal was formed of clean brass and submitted to the electrical discharge *in vacuo*; the deposit obtained was of a color of brass throughout, and on treating the deposit chemically I could detect no separation of its component metals, copper and zinc.

*Like the action producing volatilization the "red heat" is confined to the superficial layers of molecules only. The metal instantly assumes, or loses, the appearance of red heat the moment the current is turned on or off, showing that if the appearance is really due to a rise of temperature it does not penetrate much below the surface. The extra activity of the metallic molecules necessary to volatilize them is, in these experiments, confined to the surface only, or the whole mass would evaporate at once, as when a metallic wire is deflagrated by the discharge of a powerful Leyden jar. When this extra activity is produced by artificial heat one of the effects is the emission of red light; so it is not unreasonable to imagine that when the extra activity is produced by electricity the emission of red light should also accompany the separation of molecules from the mass. In comparison with electricity heat is a wasteful agent for promoting volatilization, as the whole mass must be raised to the requisite temperature to produce a surface action merely; whereas the action of electrification does not appear to penetrate much below the surface.

Returning to the analogy of liquid evaporation, if we take several liquids of different boiling points, put them under the same pressure, and apply the same amount of heat to each, the quantity passing from the liquid to the gaseous state will differ widely in each case.

It was interesting to try a parallel experiment with metals, to find their comparative volatility under the same conditions of temperature, pressure and electrical influence. It was necessary to fix upon one metal as a standard of comparison, and for this purpose I selected gold, its electrical volatility being great, and it being easy to prepare in a pure state.

An apparatus was made as in Fig. 12. It is practically a vacuum tube with four negative poles at one end and one positive pole at the other. By a revolving commutator I was able to make electrical connection with each of the four negative poles in succession for exactly the same length of time (about six seconds); by this means the variations in the strength of the current, the experiment lasting some hours, affected each metal alike.

The exposed surface of the various metals used as negative poles was kept uniform by taking them in the form of wires that had all been drawn through the same standard hole in the drawplate, and cutting them by gauge to a uniform length; the actual size used was 0.8 millimetres in diameter and 20 millimetres long.

The comparison metal, gold, had to be used in each experiment; the apparatus thus enabled me to compare three different metals each time. The length of time that the current was kept on the revolving commutator in each experiment was eight hours, making two hours of electrification for each of the four negative electrodes; the pressure was such as to give a dark space of six millimetres.

The fusible metals, tin, cadmium and lead, when put into the apparatus in the form of wires, very quickly melted. To avoid this difficulty a special form of pole was

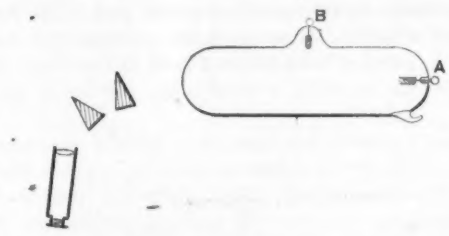


FIG. 11.—CROOKES' EXPERIMENTS ON ELECTRICAL EVAPORATION.

devised. Some small circular porcelain basins were made, nine millimetres diameter: through a small hole in the bottom a short length of iron wire, 0.8 millimetre in diameter, was passed, projecting downward about five millimetres: the basin was then filled to the brim with the metal to be tested, and was fitted into the apparatus exactly in the same way as the wires: the internal diameter of the basins at the brim was seven millimetres, and the negative metal filed flat was thus formed of a circular disc seven millimetres diameter. The standard gold pole being treated in the same way, the numbers obtained for the fusible metals can be compared with gold, and take their place in the table.

The following table of the comparative volatilities was in this way obtained, taking gold as = 100:

Palladium	108.00
Gold	100.00
Silver	82.68
Lead	75.04
Tin	56 96
Brass	51.58
Platinum	14.00
Copper	40.24
Cadmium	31.99
Nickel	10.99
Iridium	10 49
Iron	5.50

In this experiment equal surfaces of each metal were exposed to the current. By dividing the numbers so obtained by the specific gravity of the metal, the following order is found:

Palladium	9.00
Silver	7.88
Tin	7.76
Lead	6 61
Gold	5.18
Cadmium	3.72
Copper	2.52
Platinum	2.02
Nickel	1.29
Iron	0.71
Iridium	0.47

Aluminium and magnesium appear to be practically non-volatile under these circumstances.

The order of metals in the table shows at once that the electrical volatility in the solid state does not correspond with the order of melting points, of atomic weights, or of any other well-known constant. The experiment with some of the typical metals was repeated, and the numbers obtained did not vary materially from those given above, showing that the order is not likely to be far wrong.

It is seen in the above table that the electrical volatility of silver is high, while that of cadmium is low. In the two earlier experiments, where cadmium and silver were taken, the cadmium negative electrode in 30 minutes lost 7.52 grs., while the silver negative electrode in 1¼ hours only lost 0.19 gr. This apparent discrepancy is easily explained by the fact (already noted in the case of cadmium) that the maximum evaporation effect, due to electrical

disturbance, takes place when the metal is at or near the point of liquefaction. If it were possible to form a negative pole *in vacuo* of molten silver, then the quantity volatilized in a given time would be probably much more than that of cadmium.

Gold having proved to be readily volatile under the electric current, an experiment was tried with a view to producing a larger quantity of the volatilized metal. A tube was made having at one end a negative pole composed of a weighed brush of fine wires of pure gold, and an aluminium pole at the other end.

The tube was exhausted, and the current from the induction coil put on, making the gold brush negative; the resistance of the tube was found to increase considerably as the walls became coated with metal, so much so, that to enable the current to pass through, air had to be let in after a while, depressing the gauge one-half millimetre.

The weight of the brush before experiment was 35.4940 grammes. The induction current was kept on the tube for 14½ hours; at the end of this time the tube was opened and the brush removed. It now weighed 32.5613, showing a loss of 2.9327 grammes. When heated below redness the deposited film of gold was easily removed from the walls of the tube in the form of very brilliant foil.

After having been subjected to electrical volatilization, the appearance of the residual piece of gold under the microscope, using a quarter-inch object glass, was very like that of electrolytically deposited metal, pitted all over with minute hollows.

This experiment on the volatilization of gold having produced good coherent films of that metal, a similar experiment was tried, using a brush of platinum as a negative electrode. On referring to the table it will be seen that the electrical volatility of platinum is much lower than that of gold, but it was thought that by taking longer time

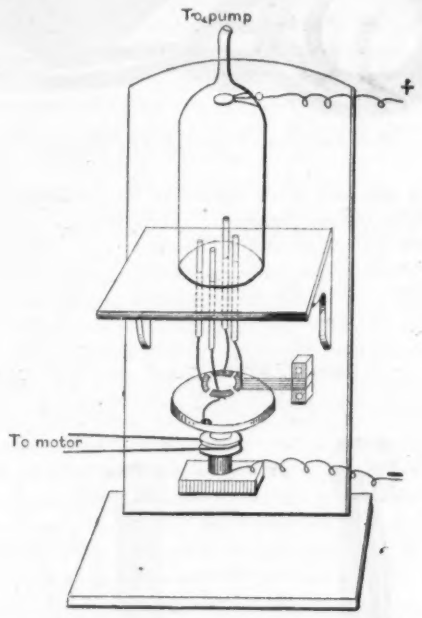


FIG. 12.—CROOKES' EXPERIMENTS ON ELECTRICAL EVAPORATION.

a sufficient quantity might be volatilized to enable it to be removed from the tube.

The vacuum tube was exhausted to such a point as to give a dark space of six millimetres, and it was found, as in the case of gold, that as a coating of metal was deposited upon the glass the resistance rapidly increased, but in a much more marked degree, the residual gas in the tube apparently becoming absorbed as the deposition proceeded. It was necessary to let a little air into the tube about every 30 minutes to reduce the vacuum. This appears to show that the platinum was being deposited in a porous spongy form, with great power of occluding the residual gas.

Heating the tube when it had become in this way non-conducting liberated sufficient gas to depress the gauge of the pump one millimetre, and to reduce the vacuum so as to give a dark space of about three millimetres. This gas was not re-absorbed on cooling, but on passing the current for 10 minutes the tube again refused to conduct, owing to absorption. The tube was again heated, with another liberation of gas, but much less than before, and this time the whole was re-absorbed on cooling.

The current was kept on this tube for 25 hours; it was then opened, but I could not remove the deposited metal except in small pieces, as it was brittle and porous. Weighing the brush that had formed the negative pole gave the following results:

	Grains.
Weight of platinum before experiment	10.1540
" " after "	8.1570
Loss by volatilization in 25 hours	2.0370

Another experiment was made similar to that with gold and platinum, but using silver as the negative pole, the pure metal being formed into a brush of fine wires. Less gas was occluded during the progress of this experiment than in the case of platinum. The silver behaved the same as gold, the metal deposited freely, and the vacuum was easily kept at a dark space of six millimetres by the very occasional admission of a trace of air. In 20 hours nearly 3 grs. of silver were volatilized. The deposit of silver was detached without difficulty from the glass in the form of brilliant foil.

High-Tension Experiments.

The following abstract of an account which has appeared in the *Elektrotechnische Rundschau* of some experiments with currents of excessively high tension which were publicly carried out last April, in Siemens and Halske's works at Charlottenburg, may prove interesting. The apparatus (see Fig. 4 comprised a 25 h. p. 1,000-volt alternator excited by current from a battery of accumulators. The current from the alternator was taken to a step-up transformer (1,000—20,000 volts), thence along a line to two step-down transformers (20,000—1,000 volts and 1,000—100 volts). The actual existence of the 20,000 volts was

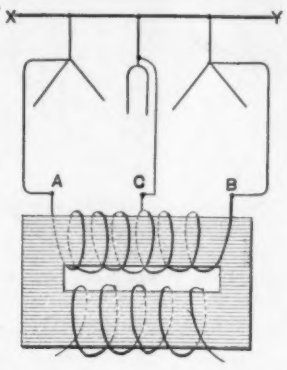


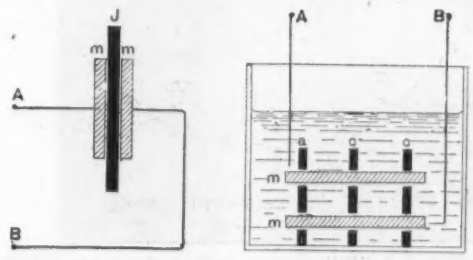
FIG. 1.—HIGH TENSION EXPERIMENTS.

rendered visible by the illumination of 200 100-volt incandescent lamps arranged in series across the terminals *A B* of the first transformer.

According to Herr Kopsel, who conducted the demonstration, the only possible solid insulator for high-pressure work is specially prepared vulcanized india rubber. A sheet of vulcanized india rubber 1.5 millimetres thick, and prepared by a special process of Siemens and Halske, was then exposed to a pressure of over 20,000 volts without its being pierced, or, indeed, suffering in any way. Various cables were then exposed to high voltages; one gave way at 16,000 volts, and another successfully withstood more than 20,000 volts.

When testing solid insulating bodies the apparatus shown in Fig. 2 was employed, *m m* being two metal plates in connection with the terminals *A B*, and *J* being the substance under test. In order to protect the transformer on the breakdown of the insulation the 200 100-volt lamps were connected in series with the plates *m m*, which arrangement also rendered the rupture of the insulation visible to all present by the incandescing of the lamps. A piece of compressed cardboard one millimetre thick broke down at 2,000 volts, and a sheet of glass of the same thickness gave out when about 10,000 volts were applied. In the case of the latter a beautiful luminous phenomenon was witnessed. A blue glow appeared all round the edge of the brass discs, where they were in contact with the glass, the glow being accompanied by a sharp crackling. When testing liquid insulating bodies the apparatus shown in Fig. 3 was employed. Two brass plates *m m* were placed in a glass vessel containing the liquid to be tested, the plates being kept in position by vulcanite distance pieces *a b c*. The experiments showed that although oil was an excellent insulator it lost this quality in a large measure after it had once been pierced by a spark. After the passage of a spark it frequently broke down at 4,000 volts. The reason given was the decomposition of the oil by the spark and the consequent formation of a sort of conducting bridge of carbon particles.

Experiments were then made to show the distribution of potential in a transformer. A number of tinfoil electro-



FIGS. 2 AND 3.—HIGH TENSION EXPERIMENTS.

scopes were connected to a rod of vulcanite, *X Y* (Fig. 1). On connecting electroscopes to the points *A B* and *C*, the leaves at *A B* diverged, while those at *C* remained closed; showing that the potential at this point was the same as that of the earth. If a second transformer was connected up, sparks could be drawn from the iron core of this transformer as well as from the secondary coil. Judging by the length of the sparks their potential was equal to the potential of *B*. The leaves of an electroscope connected to the core diverged widely. The distribution of potential was also rendered visible by connecting up the 200 100-volt lamps. While carrying out this experiment it was observed that the carbon filaments of the lamps nearest the ends of the series vibrated so energetically that at times they struck the bulbs. This phenomenon may be attributed to electrostatic action between the filaments and the glass, and the effect was more marked at the terminals because of the greater difference of potential. On connecting up one end only of the lamps to the transformer, and by choosing lamps with the proper degree of exhaustion the whole series was made to phosphoresce. This phenomenon may be explained if the globes and the filaments have all the same difference of potential between them; equilibrium would then be produced by a silent discharge. Several experiments on the sparking distances in air of various high pressures were then performed.

The Collier Audible Telephone.*

The telephone will be the object of much discussion, of rapid organization, and possibly of sharp business or legal action in the next few months. In July the carbon transmitter patent will run out. The Bell telephone is now open to the world, and already considerable progress has been made in the organization of exchanges with Bell instruments alone by the Mutual Telephone Company in Manchester and elsewhere. The great telephone companies will have to look very sharply to their laurels, and none will be surprised and few disappointed if these monopolists, who have so long held the field without having done much to deserve it, are ousted from their position. Added to the present situation of the expiry of master patents, the introduction of a far more powerful receiver than any hitherto known would have a powerful effect in the extension of telephonic systems, if conjoined, as it should be, to double-circuit wires, ready and courteous attention, and the best skill of experienced electricians.

We here wish to speak of a new departure, not in transmitters or switches, but in the telephone receiver itself. To double or treble the sonorousness and audibility of the telephone receiver is no mean achievement, and would hardly be deemed possible were it not obtained by such simple and easy means.

The Collier Audible Telephone, which we illustrate herewith, is, curiously enough, not the invention of any of the telephone engineers or employés, not even of a professed

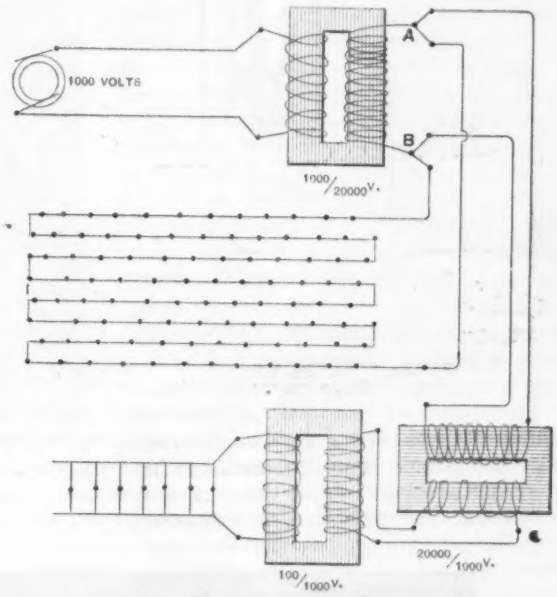


FIG. 4.—HIGH TENSION EXPERIMENTS.

electrician, but of a Congregational minister, Mr. Arthur T. Collier, of Sydney, New South Wales. Mr. Collier, being greatly interested in electrical and mechanical work, and hitting upon the idea of his telephone, has given up for a time his charge in Australia, and is now residing in England, bent upon the introduction of his invention. A syndicate has been formed, having offices in 38 Gray's-Inn-Road, and works on some scale are being established in Manchester.

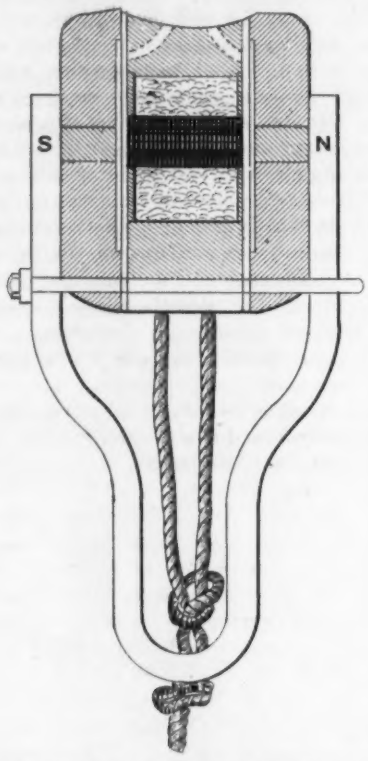
So much by way of preface. The telephone itself embodies two simple ideas, for the embodiment of which patents have been taken in England, America and the colonies, etc. These are (1) the employment of a soft-iron armature placed directly in between the poles of the magnet, thus using two poles, and with this two vibrating diaphragms—one between each pole and the core; and (2) the method of taking the sound of the vibration from inside the diaphragm box, instead of outside, as now usually done. This latter arrangement in itself gives a greater volume of sound, by reason both of the greater activity of the magnetization and also from the additional magnetic variations that go on in the core—effects that have been already noticed, but not used. By combining these ideas and using two diaphragms the telephone receiver is rendered far more sensitive, and its sound very much louder and more distinct. So much so is this, that the sound from a Collier telephone entirely overpowers that from a Bell receiver on the same circuit, almost as a person shouting against a whisper. The sound is almost of a sufficient volume to fill a small room; and it is stated that the difficulty with the telephones in India—viz., that the natives of one caste will not use the instrument placed against the ear of a native of another caste—is now obviated, as it is not necessary to place the telephone close to the ear in order to hear speech.

The construction of the Collier telephone is seen in the detail drawings. The core of soft iron, laminated both end and lengthwise, is mounted on an insulating reel, and wound with wire. It is then mounted into a solid block of ebonite, having a ring turned out as usual,

*From the *Electrical Engineer* (London).

to grip the metal diaphragm. On either side is a pole-piece, the two forming the poles of the magnet, each nearly touching the diaphragm. The magnet itself is placed outside the whole, its N. and S. pole inclosing the diaphragms in a strong magnetic field. From the inside surface of the two diaphragms three small holes are led up each side to the mouthpiece of the telephone. This mouthpiece has a small cone, as shown, to lead and concentrate the sound into the ear. The result is extraordinary. Not only is the sound very loud—painfully so when the ear is too close—but the delicacy of this instrument, according to tests taken, is phenomenal. The instrument fitted with the iron pole alone, *without any magnet*, is found louder than the ordinary double-pole Bell form of telephone, now, perhaps, the most powerful receiver.

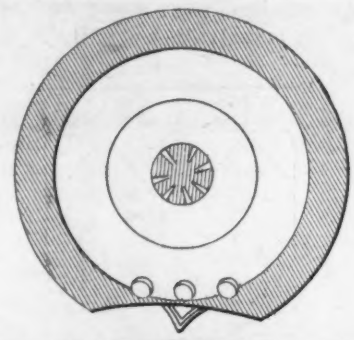
With the complete instrument the delicacy seems almost without limit. From the experiments undertaken upon



SECTION OF COLLIER TELEPHONE.

the Collier telephone, Mr. W. F. Bottomley, the manager of the Telephone Company of Ireland, says: "I have made a number of tests under different conditions with the instrument, with and without transmitters, and under all circumstances there can be only one opinion—that the Collier instrument is unsurpassed, and will be generally preferred in practice. From the experiments made, I am satisfied that conversation with this instrument, without the aid of a microphone, could be carried on with distinctness and comfort over a line of 5,000 miles."

This is pretty strong testimony, but a further practical test will show the sensitiveness of this instrument in even still more forcible form. Mr. Wm. E. Heys, M. I. E. E., of Manchester, says: "I beg to report that I have carefully tested a pair of your telephone receivers, and find them immeasurably superior to any other instrument which I have ever examined in their susceptibility. I estimate its loudness as being from three to four times greater than that of the best examples of the 'double-pole Bell' and 'Ader' instruments. In arranging the resistances I have been careful to avoid coiled wires or parallel circuits. In order, also, to eliminate any disturbing influences, I have avoided the use of a battery in the circuit and carbon transmitters, the best of which are variable. In making all my tests I used a 'Collier' telephone as a transmitter. The source of sound employed was a metronome rigidly fixed relatively to the transmitter, care being taken to keep the spring of the metronome at about the same tension in all the experiments. The resistances employed were a column of pure water four millimetres in diameter, and a carbon film on oiled paper. The instrument used as a basis for comparison was a double-pole Bell of first-rate efficiency: With the water column the sound of the metronome disappeared altogether at from 6 to 18 centimetres with the Bell instrument with different observers, the length of the water column being practically constant for each observer. With



SIDE VIEW OF COLLIER TELEPHONE, SHOWING IRON CORE.

the longest water column (150 centimetres) at my disposal at the time of testing, the Collier instrument gave perfectly audible results. The conductor was then taken away from the water column, and the observers, taking the ends of it in their hands, removed a distance of 15 feet, when the sound was still perfectly audible. The resistance then was 150 centimetres of water, 100 centimetres of linoleum, 400 centimetres of thick pile carpet, all dry, and a human body. The observers were then carefully insulated at the same distance by thick glass, with only a small reduction of the sound. The conductors were thickly insulated, and proof that the current must have taken the course indicated is found in the fact that immediately the observer broke the circuit by dropping the wire the sound ceased. The experiments with the carbon film gave corresponding results. I have not attempted to take the ohmic resistances, because I could not find any measurable resistance which excluded the sound with the 'Collier' telephone. Electrically, the 'Collier' telephone is far more than 10 times and phonically more than three times more effective than the best 'double-pole Bell' or 'Ader' instruments."

We understand that the Collier telephone has received careful tests and great commendation from Mr. A. R. Bennett, of the Mutual Telephone Company, who has suggested a shape, which is now being manufactured, very similar to the usual Bell instrument, to which exchange subscribers are accustomed. An order for 500 of these telephones has been given on their merits by one of the large English railway companies. A really loud-speaking telephone will be of immense use to the railway companies, not only for ordinary messages, but even for a simple form of sounder, and the possibility of communication from guard to engine-driver is also to be considered. When the telephone patents are definitely free a very large field will be open for their use in railway working, till now almost unoccupied. The possibility of sending signals by means of a simple core and two diaphragms without magnets also opens a new vista, and may develop important consequences, while the extreme sensitiveness of the instrument may make it invaluable in research work.

We may also add that the Collier Audible Telephone Syndicate is backed by the London and Colonial Finance Corporation, and a company is intended to be shortly formed, whose shares will be offered to the public. We have little hesitation in saying that Mr. Collier seems to have hit upon a very good idea, and there is every evidence, from the samples of work we have seen, that he is able to carry out his invention in a thoroughly practical and useful manner.

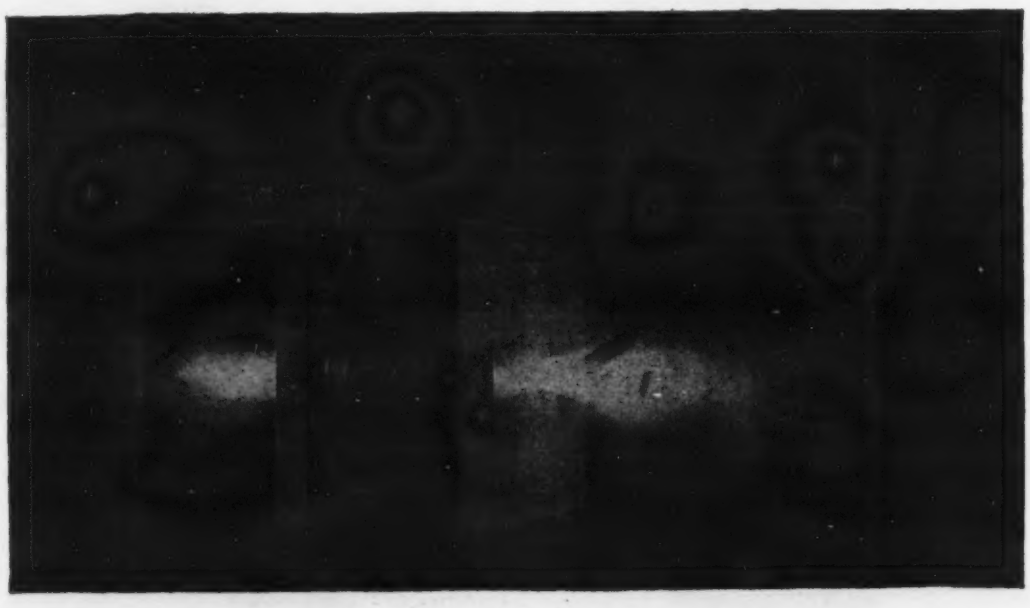


FIG. 1.—THE WURTS-WINSOR LIGHTNING ARRESTER.

The Wurts-Winsor Lightning Arrester.

The accompanying illustrations represent the new style of the Wurts-Winsor lightning arrester for incandescent circuits. While it has not been changed in principle the modifications add much to its simplicity. Its distinctive features are that it is made out of incombustible material, it operates without any electromagnetic device, and its arc is self-destructive.

Fig. 2 represents the lightning arrester in its normal position ready for a discharge. The apparatus is compact, consisting of very few parts. It has a cylindrical air chamber of brass, each end of which is covered with a marble plate. Two discharge points on opposite sides of the air chamber, consisting of brass tubes tipped with carbon, are attached to brass lever arms in such a manner as to swing freely through circular openings in the marble plates. Within the air chamber is a carbon ball held stationary in the centre, and the two discharge points approach this ball to within one-sixteenth of an inch. The carbon ball is grounded and the lever arms connected to the respective poles of the generator.

The operation of a discharge is simple and effective. Suppose a lightning discharge to come in from the line, the discharge will take place from the two discharge points to

THE COLLIER AUDIBLE TELEPHONE.

the carbon ball and from thence to the ground, forming a double arc in the air chamber. The dynamo current will then follow, causing a short circuit on the generator, and the heat produced by these arcs will expand the air in the chamber and drive the two discharge points out, thus extinguishing the arcs and rupturing the short circuit. The next moment the discharge points swing back to their former position within the chamber, and the apparatus is at once ready for another discharge. The entire operation is automatic, and when the lightning arrester is once placed in position it requires no further attention.

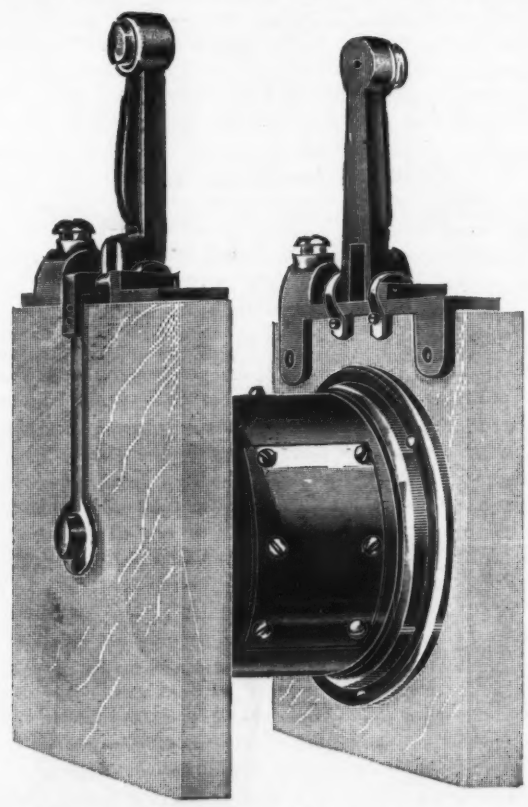


FIG. 2.—THE WURTS-WINSOR LIGHTNING ARRESTER.

Fig. 1 is taken from a photograph, and represents the arrester in actual operation. In testing one of these arresters the binding posts were connected to the poles of a 1,000-volt 1,500-light alternator, and the two air spaces were bridged over with a small strip of tinfoil. Then by the throw of a switch the generator was short-circuited through the arrester, the tinfoil was fused, the air expanded, the discharge points were forced out of the air chamber against the bumpers, the arcs were blown out with a report like a pistol shot, and the discharge points returned to their normal positions ready for a fresh discharge, all in an inconceivably short space of time. After several hundred such discharges the arrester showed no deterioration whatever.

The Westinghouse Electric and Manufacturing Company also makes lightning arresters on the same prin-

ciple, but differing in construction, for power-house installations and car equipments of electric street railway companies.

An Edison Mining Drill.

The accompanying illustration shows the electric drill of the Edison Company at work on a shaft column, the view being taken from a photograph in the Last Chance mine at Wardner, Idaho. Before the installation of this drill the operation of two air drills which were in use for 24 hours each day required five cords of wood, while the total consumption of fuel for four electric percussion drills now in operation, running for the same length of time each day, is only one and a half cords, and in this case each drill is said to do more work than a single drill operated by air. As a result of these facts, all the air drills formerly in use in the mine have been replaced by electric drills. The pneumatic plant was situated 1,000 feet higher up the mountain than was required with the electric drills, and the fuel had to be carried to the air plant this increased distance over that necessary for the electric plant.

AN EDISON MINING DRILL.

A Small 500-Volt Motor.

The great increase in street railway and other power circuits of a pressure of 500 volts has recently led to a demand for small motors and fan outfits adapted to this voltage.

The problem of designing a one-eighth or one-quarter horse power motor for so high a voltage has many difficulties that are not met in building larger machines, while some of the main objects to be attained in large machines assume a very different aspect in these pigmies. For example, in the matter of economy of copper these small motors cannot be laid out for the least weight as in larger ones, owing to the great increase in cost of the smaller sizes of wire, so that the least cost may be far from being attained in a machine possessing the least weight. Again, one is limited by the mechanical strength of the wire, as the finer sizes are apt to be drawn out or broken in the rapid handling necessary in manufacturing on a large scale. Another difficulty in designing is the limitation insize, especially in fan outfits, which must be small enough to move from place to place, while at the same time the area of the pole pieces must be large enough to reduce the armature turns to a reasonable number. Finally, the cost of construction must be reduced to a minimum, as the wire alone on a high voltage machine may cost as much as a whole motor of low voltage.

With these points in view a small motor has been designed by Mr. F. V. Henshaw, of the "C. & C." Electric Motor Company, of this city.

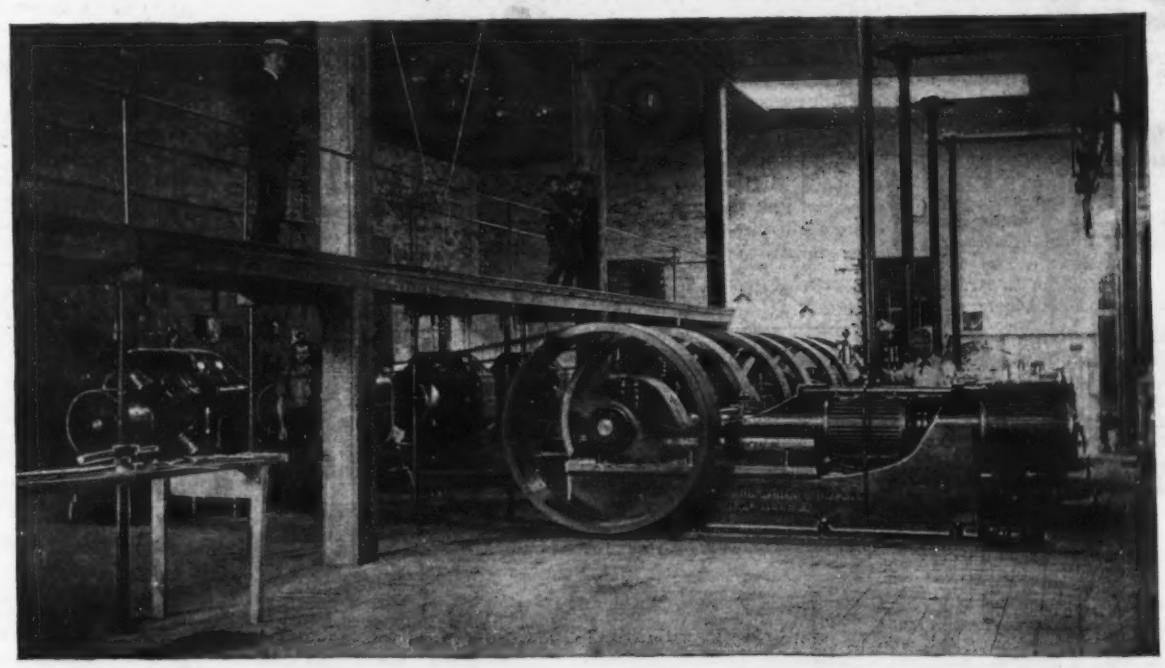
The field magnet is semi-ironclad, being formed of two castings joined at one end and held by a single bolt, while the opposite projecting ends form the poles. The lower casting has a cylindrical core, over which the single field coil is slipped. This core is cast hollow, and the shaft passes through it, having bearings at each end. As will be seen, this arrangement allows a relatively large diameter of armature without increasing the size of the machine greatly. The armature is of the ring type, supported on the shaft by three arms. The whole front of the armature is covered by a rubber disc against which the commutator is fastened. This disc serves to keep the frail connecting wires in place and also as a protection to the armature. The brush-holders carry two or more round carbons of standard size, which can be replaced by simply turning the holder around, putting in new pieces and turning back. Both field and armature coils are wound separately on a lathe. With duplicate sets of armatures and field bobbins of the proper winding it is but the work of a few minutes to change these machines from one voltage to another, which is sometimes convenient.

The one-eighth h. p. motors are finished with bearings requiring very little oil, while the larger motors have self-oiling bearings.

Motors of this size and wound for 500-volt circuits will doubtless find a very wide field of application, not only in the repair shops of electric street railway companies, but also in many private residences and shops situated along the line of the circuit which carries current of this voltage o street cars.

Street Railway Work in Lincoln, Neb.

Since April 15 40 miles of electric railway have been completed at Lincoln, Neb., one-half of which is centre-pole construction and the remainder span work. The line and track work was in charge of Mr. L. W. Childs and Mr. S. L. Barry, of Boston. In the track work no supplementary wires were used but a double system of bonding. In the power-house, an interior view of which is shown in the accompanying illustration, there are three 200-h. p. Manning upright tubular boilers and four 125-h. p. tandem compound engines, built by the Phœnix Iron Works Company, of Meadville, Pa. The electrical equipment consists of four Thomson-Houston generators having a capacity of 75,000 watts each, installed by Mr. P. E. Begley.



RAILWAY POWER PLANT AT LINCOLN, NEB.

The car equipment includes 15 16-foot cars, equipped with the Short standard motors, and there are to be five cars equipped with the new gearless motor of the same company. This work was in charge of Mr. F. G. Daniell. The line has been running about two weeks without a breakdown or mishap of any kind, although the first day the road was in operation over 8,000 people were carried to the ball game with eight cars and an equal number of trailers. The road is owned by F. W. Little & Co., and the work has all been done under the direction of J. Barry & Co., of New York, Mr. Thos. J. McTighe being in direct supervision of the work.

A Gravel-Pit Plant.

That the use of electric lights has greatly facilitated work of every character is too well known to need repetition, a recent installation made by the Chicago & Northwestern Railway Company merely emphasizing the fact.

At Grand Mound, Iowa, 163 miles west of Chicago, the company is working an extensive gravel pit and using the many thousand carloads removed in improving its roadbed. Heretofore the men have seldom worked at night, owing to the insufficient illumination afforded by the kerosene torches and the liability of the workmen being struck and injured while the crane was swinging in the semi-darkness. A short time ago it became necessary to work the pit constantly both night and day, and to secure the necessary light a No. 2 Edison dynamo and a Rice 7 × 12 automatic engine were sent out and bolted to a foundation of old bridge timbers, and the necessary steam pipes from the boiler of the pumping plant located at the water tank near by. A pole line 1,200 feet long was quickly put up and six Ward arc lamps and a number of incandescent lamps placed in circuit, the latter being distributed about the dynamo and engine and other machinery. Four of the Ward lamps are placed on poles and so distributed as to perfectly illuminate not only the face of the bluff, but also the surrounding grounds for a considerable distance. The other two Ward lamps are placed on the steam shovel, and it is worthy of note that though the old machine vibrates so strongly as to sometimes shake the workmen off, yet the lights burn very steadily. The circuit connecting in these latter lamps is made portable and connected to the main line each night as the steam shovel takes the position it will occupy for the next few hours while loading the gravel into the flat cars. The installation was made by Mr. Carl K. McFadden, of the Electric Light Department of the Chicago & Northwestern Railway, who also operated the plant during the first week's run, under the direction of Mr. G. H. Thayer, Superintendent of Telegraph and Chief of the Electric Light Department. Mr. Thayer is a firm believer in the efficiency of the Ward lamps for incandescent circuits, having displaced all the incandescent lamps in the Wells street station, Chicago, with Ward arc lamps.

The application of the electric light to work of this kind is much more general than it was a few years ago, though it is still much less extended than it should be. Not many years ago the first portable electric light plant was put into operation for lighting a circus exhibition, but now almost every show of this kind from Barnum's to Buffalo Bill's is illuminated from a plant of more or less elaborate character, according to the nature of the service, mounted upon a movable vehicle, forming an entirely independent unit. Similar plants are now in use on many railroads to assist in removing wrecks and doing night repair work.

The Proposed Pacific Cable.

The following extract is from the *Shanghai Mercury* of May 1, 1891. Up to the present time the greatest depth from which a submarine cable has been recovered is 2,720 fathoms. "The survey made by Rear-Admiral Belknap, U. S. N., of the North Pacific, demonstrates that the proposed great circle for a submarine cable is not feasible. His soundings indicate the existence of a trough or basin of extraordinary depth and extent, along the east coast of Japan and the Kurile Islands, and under the Kuro Siwo, or Japan or Black Stream. The basin exceeds any similar depression yet found in any other regions of the great oceans. In a run of 30 miles after leaving the coast of Japan the waters deepened more than 1,800 fathoms, and upon the next cast of the lead the wire broke after 4,643 fathoms had been run out without bottom having been reached. Thermometers specially constructed for deep-sea sounding were wrecked by the unprecedented pressures. The depth of the deepest cast—five miles and a quarter, the deepest water yet found—is sufficient to hold two mountains as high as Japan's great Fusiyama, one on top of the other, and then the summit of the highest would be nearly two-thirds of a mile under water. This region of the Pacific has been named the 'Tuscarora Deep.'"

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

Chicago Quotations.—Col. S. G. Lynch, broker, 153 Monroe street, Chicago, furnishes quotations on telephone and electric light stocks as follows:

Chicago	$230@$240	Cumberland	$60@ $62
Central Union	53@ 55	Wisconsin	118@ 120
Michigan	83@ 85	Bell of Missouri	160@ 165
Great Southern	30@ 32	Iowa Union	20@ 22
Colorado	31@ 36	Missouri and Kansas	54@ 56
Rocky Mountain Bell.	40@ 43		

ELECTRIC LIGHT STOCKS.

Chicago Arc Light and Power	$99@$100	Chicago Edison Co.	$145@$150

NEW INCORPORATIONS.

The Granite Falls Electric Power Company, of Snohomish City, Wash., has been incorporated with a capital stock of $2,000.

The Southern Electric Company, of Lynchburg, Va., was incorporated with a capital stock of $10,000, instead of $1,000 as previously mentioned, and has the right to increase it to $25,000.

The Gregg Electric Cure Company, of Chicago, Ill., has been incorporated with a capital stock of $50,000. The incorporators are: A. W. Underwood, Edwin T. Coman and Charles Shackelford.

The National Gas and Water Company, of Chicago, Ill., has been incorporated to operate gas, water and electric works. The capital stock is $500,000. The incorporators are: C. D. Hank, E. E. Morrell and N. A. McClary.

The Solar Incandescent Lamp Company, of Chicago, Ill., has been incorporated to manufacture electric lamps and fixtures. The capital stock is $100,000. The incorporators are: M. L. Coffeen, George R. Mitchell and Charles H. Wells.

The Columbian Electric Works, of Chicago, Ill., has been incorporated for the manufacture and sale of all kinds of electric apparatus. The capital stock is $3,000,000. The incorporators are: Samuel E. Moore, Louis S. Day and John Irvine.

The Equitable Electric Company, with a capital stock of $250,000, has been organized at Jersey City, N. J. J. M. Glover, of St. Louis, Mo.; L. Murray, 45 Broadway, New York, and A. A. Rice, 201 Washington street, Jersey city, N. J., are interested.

The Applegate Electric Conduit Railway Company, of Chicago, Ill., has been incorporated to engage in a general electric business. The capital stock is $2,500,000. The incorporators are: W. H. Applegate, William H. H. Thomas, S. H. O. Homewood.

The Empire Electric Company, of Chicago, Ill., has been incorporated to manufacture electrical and other merchandise, and to deal in patent rights relating to the same. The capital stock is $1,000,000. The incorporators are: C. E. Gaylord, C. N. White and M. J. Frost.

The South Harvey and Harvey Electric Dummy Railroad Company, of Chicago, Ill., has been incorporated to operate an electrical dummy railroad. The capital stock is $25,000. The incorporators are: W. C. McClintock, Isaac A. Hartman and Fred A. Bangs.

The National Light, Heat and Power Company, of Chicago, Ill., has been incorporated with capital stock of $100,000 to establish an electric light plant, electric railway and furnish power. The incorporators are: Harrison M. Angle, Charles C. Arnold and P. E. Crissey.

The Edison Light and Power Company was organized July 1, at San Francisco, with a capital stock of $3,000,000, to generate, transmit and sell electricity, electric light, heat and power, etc. Messrs. F. F. Upton, Chas. Sutro, Jr., and W. F. Sell, of Berkeley, Cal., are interested in this new company.

The Standard Railway Gate and Manufacturing Company, of Chicago, Ill., has been incorporated to manufacture railway safety gates, signals, frogs and railway supplies of all kinds. The capital stock is $300,000. The incorporators are: S. M. Meek, Thomas M. Meek and Oliver R. Trowbridge.

The Eastern Electric Supply Company, with a capital stock of $250,000, has been formed in Portland, Me. It will deal in electrical appliances and supplies of all kinds. Maybin W. Brown, Hyde Park, Mass., Albert Otis Smith, Boston, Mass., and Geo. H. Buckminister, Everett, Mass., are interested therein.

The Armour Electric Light, Fuel and Power Company, of Chicago, Ill., has been incorporated to manufacture machinery for the production of light, heat and power. The capital stock is $5,000,000. The incorporators are William L. Armour, Martin C. Burt, Alien T. Bennett and Clarence O. Scudder.

The Norwood Park and Maine Electric Railway Company, of Chicago, Ill., has been incorporated to operate a street railway from the village of Desplaines to some point in the City of Chicago. The capital stock is $250,000. The incorporators are: F. J. Short, M. E. Cole, Russell O. Dunning and Andrew Dunning.

The Millville Electric Company, of Millville, N. J., has just been organized, with a capital stock of $50,000. It is to pursue the business of manufacturing, supplying and transmitting heat, light, power and sound. Among those interested are W. D. Kemble, G. B. Langley, of Millville, N. J., and W. Wood, of Philadelphia.

The Kennebunk Electric Light Company, Kennebunk, Me., was lately organized, with a capital stock of $100,000. It is to take up the business of supplying the towns of Kennebunk, Kennebunkport and Wells with light, heat and power. R. W. Lord, Sidney F. Fuller, Chas. R. Littlefield, of Kennebunk, are among the promoters.

The Birmingham, Knoxville & Allentown Traction Company has been started at Pittsburgh, Pa., with a capital stock of $1,000,000. Its purpose is the construction and operation of motors, cables and other machinery for passenger railways, etc. The following are interested: H. Sellers McKee, James A. Chambers, of Allegheny, and M. A. Verner, of Pittsburgh.

The Interstate Electric Railway Company, of Milwaukee, Wis., was incorporated last week with a capital stock of $10,000,000, to construct and maintain an electric railway between Chicago and Milwaukee. G. J. Cox, F. H. Deleglen, R. H. Clark, C. T. Goodrich, C. E. Crain, J. W. Dickinson and I. C. Edwards are interested in promoting the interests of this concern.

The Brighton Park Mutual Home and Investment Company has recently been incorporated, with its office at Branchville, Md. Its capital stock is $250,000, and its business is the buying, selling, leasing, mortgaging and improving of land, and the construction and equipment of a railway, and gas and electric lighting. Among the gentlemen interested in this company are the following: J. H. Rolstein, of Hyattsville, and Pinkney A. Scaggs, of Branchville, Md.

The Columbian Light, Heat and Power Company, of Chicago, Ill., has been incorporated. The capital stock is $3,000,000 and the incorporators are Newton A. Partridge, Samuel E. Moore and John Irvine, all of Chicago. The company will bring out a new system for heating and lighting buildings, but the promoters decline to say anything definite concerning the projects because all their patents are not yet secured. The plant will probably be located at South Evanston, a suburb of Chicago.

AFFAIRS OF THE COMPANIES.

The Corpus Christi (Tex.) Electric Company has filed an amendment to its charter, increasing capital stock by $10,000.

The Edison Illuminating Company, has declared its regular quarterly dividend of one per cent., payable on Aug. 1.

The Malden (Mass.) Electric Company has declared a quarterly dividend of two per cent., payable July 15, to stock of record July 10.

The National Telephone Manufacturing Company held its annual meeting at Portsmouth, N. H., on Saturday of last week. The transfer-books were closed July 1, to be reopened on July 14.

The United Electric Securities Company, of Boston, Mass., invites proposals for the sale to the company of $30,000 of its first series and $20,000 of its second series collateral trust sinking fund five per cent. bonds.

The Tropical American Telephone Company, Limited, will hold its annual meeting at the company's office, Long Branch, N. J., on Wednesday, July 29, at 10 A. M., for the election of officers, for action on the question of paying a dividend and on the question of acquiring a valuable patent, and for the transaction of such other business as may legally come before the meeting.

The Tropical American Telephone Company, Limited, presents the following statement of assets and liabilities as of date Jan. 1, 1891: Assets: Bills receivable, $30,999.36; merchandise on hand, $11,400; treasury stock, 3,000 shares, $3,000; cash in bank, $8,232.14; total, $53,631 50. Liabilities: Bills payable, $2,505.39; balance, $51,126.11, or $1.25 per share. This balance is aside from patents, franchises, contracts, and a growing business earning over five per cent. net on its entire capital at par. The capital of the company is $400,000, 37,000 shares issued, par value $10 each. The company's sales last year were more than $100,000, and the sales for the six months to Jan. 1 over $56,000.

The American District Telegraph Company, at Philadelphia, Pa., it is reported, is in good financial condition. The plant is worth $109,962, with 12 offices. The company handled 75,202 more telegrams in 1891 than in 1890; increased receipts, $5,342; surplus earnings, $32,450. The defalcation of A. T. Secor for $7,975 was charged to profit and loss. The number of local messages carried was 24,571. The total number of messages handled was 502,143. The receipts for messenger service were $39,044.60. It has recently acquired the State right for an improved watch, clock and burglar alarm system, which will be introduced. The Board of Directors is composed of C. Hartman Kuhn, Edward J. Mathews, George Kelly, John Rommel, Jr., M. Richards Muckle, Edward C. Platt, Theodore M. Etting, Henry Nuss, Jr., Benoni Frishmuth.

The Westinghouse Reorganization.—A Pittsburgh dispatch says: "The reorganization plan of the Westinghouse Electric and Manufacturing Company gives every promise of success. Already enough stock has been surrendered to warrant the committee in going ahead with the reorganization. Mr. Westinghouse is well pleased with the assured success of the plan. In speaking of a change in the time for closing the transfer-books he said: 'That simply meant that the books would remain open until 5 o'clock on July 13. We decided to do this in order to give all an opportunity to come in. We received letters and telegrams from various stockholders asking further time, and decided to grant it. We desire to have all the stock turned in; and, from present indications, I believe it will be turned in. It has not been decided under what additional conditions the stock will be received; but if there are any additional conditions they will be exceedingly mild and fair ones, and such as could cause no objection. There seems to be nothing to prevent the success of the reorganization. There has been received considerably over 90 per cent. of the stock, and I believe we will get the 100 per cent. Up to 3 o'clock yesterday 125,064 shares had been surrendered, and word was received that 5,000 more were in the mails. I expect this week will see practically every share surrendered.'"

Special Correspondence.

NEW YORK NOTES.

Office of the Electrical World,
167-177 Times Building, New York, July 13, 1891.

The New York Electrical Society.—In response to the courteous invitation of the Palisades Amusement Company and the Thomson-Houston Electric Company, the members of this society visited El Dorado, the summer resort on the Palisades at Weehawken, N. J., on Friday evening of last week. The fine electric lighting plant was inspected under the direction of Mr. C. R. Dean, the representative of the Thomson-Houston Company, and Mr. W. J. Hammer, the consulting electrical engineer of the Palisades Amusement Company. The lighting plant consists of three Thomson-Houston arc dynamos, each of 53 lights capacity, besides a Thomson-Houston incandescent light machine. A McIntosh & Seymour engine of 60 h. p. drives two of the arc machines by means of Underwood cotton leather belts, and another engine of 90 h. p. drives the other dynamos. The entire equipment was installed by Messrs. Pierce & Thomas, of 42 Cortlandt Street, New York City.

A School of Electricity for New York City.—A gentleman called at the office of The Electrical World one day last week to make inquiry regarding the extent of the demand for practical instruction in the elementary branches of the science of electricity, and when informed that there is an increasing demand for such instruction he said he was considering the idea of opening a school which would meet such a demand, at a popular price, with an afternoon class for schoolboys, and an evening class for those unable to attend during the day. As the establishment of such a school as is proposed would necessitate the expenditure of a considerable amount of money before opening, it has been thought best to learn something of the *real* interest that would be taken in such an institution, and to that end all who are *practically* interested may send their names and addresses to W. McV., care of The Electrical World, when they will receive further information concerning the proposed arrangements.

NEW ENGLAND NOTES.

Branch Office of The Electrical World,
Room 8, Cook Building, cor. Franklin and Congress Sts.,
Boston, Mass., July 11, 1891.

Mr. W. E. Stowe, formerly with the Standard Electrical Supply Company, of this city, and now located in New York, was in town this week.

The Holtzer-Cabot Company has moved its offices from 111 Arch street to 92 Franklin street, where it has much better quarters, a move which was made imperative by the increase in the company's business.

Messrs. Locke Brothers, of Salem, Mass., had a narrow escape from being burned out Friday night. The fire was supposed to have been caused by incendiaries, and was set in the dust shaft of the Lovejoy shoe shop, but was discovered in time to prevent loss.

The John Becker Machine Company will remove its entire plant about Sept. 15 to much more convenient quarters in buildings erected, especially for the purpose at Fitchburg, Mass. The increase of business and need of suitable accommodation here is the cause of the change.

Mr. Charles H. Herrick, manager of the Wright Electrical Engineering Company, has been doubly afflicted by the death of his father, some two weeks ago, and the loss of his wife, whose death occurred on Wednesday last, from heart failure. The sympathy of his many friends will be extended to him in this hour of trouble.

The Consolidated Motor Company expects to have its new road carriage run by a motor using the "Lugo" storage battery on exhibition this week. This will doubtless create quite a sensation, as there are many entirely new features to be introduced in this machine, not the least of which is the storage battery, for which are claimed excellent results.

The Thomson-Houston Company is installing in many factories and other manufacturing concerns throughout the country its system of freight tramways, which is everywhere giving the best of satisfaction. This system uses a low voltage and is perfectly safe in every way. A very good illustration of this tramway can be seen at the works at Lynn, Mass.

Mayor Mathews has decided to place the control of wires for the city of Boston under the supervision of the Fire Department, thus virtually consolidating the two departments. Mr. B. S. Flanders, who had the position of superintendent of wires in addition to his position of superintendent of fire alarm and police signal wires, is thus relieved of the extra work entailed by the former position.

Street Railway Controversy in Pittsfield, Mass.—A lively controversy has been going on between the city government and the electric street railway company. The trouble originated from the fact that the street railway company set poles, strung wires and started the electric cars without a permit from the city government. The aldermen have held one or two stormy meetings recently to see if a permit could not be granted and be signed by the mayor. The officers of the railway company met the aldermen and tried to adjust matters satisfactorily, but up to the present time they have failed to do so.

C. A. B

PHILADELPHIA NOTES.

Branch Office of The Electrical World,
31 City Trust Building, Philadelphia, July 11, 1891.

The Western Union Removal.—The work of finally removing the wires of the Western Union Telegraph Company from the old office, at South Penn Square, to the new main office at Tenth and Chestnut streets will be completed this week. The through wires are still at the old office and will be all transferred. The company now has a complete office at Tenth and Chestnut streets.

Mr. Shultz, who is associated with Mr. C. M. Blanchard in organizing the Lock Haven Electric Company, is at present in Lock Haven, Pa., where he has been for over a week past on the business of organizing the company and collecting stock subscriptions. Mr. Shultz reports great success in his work, and says that the citizens of Lock Haven are rapidly becoming financially interested in this "new company."

The Equitable Engineering and Construction Company, of Philadelphia, Pa., has just completed an additional feeder for the Richmond & Manchester Railway Company, of Richmond, Va. The company is also doing the electrical construction and equipment for the North Side & Highland Park Railway Company, of Richmond, and the construction for the Lebanon Anvill street railway at Lebanon, Pa.

WESTERN NOTES.

Branch Office of The Electrical World,
Chicago, Ill., July 11, 1891.

Mr. W. H. Blood, Jr., of the Franklin Electric Company, of this city, made a business trip to Chicago last week.

Mr. P. C. Ackerman, the New York sales agent of the American Electrical Works, is a welcome visitor in Chicago this week.

Mr. Bailey, Western manager of John Robeling's Sons' Company, with headquarters at Chicago, is a welcome visitor this week.

The Eclipse Clutch Works, Beloit, Wis., has recently added another 500 h. p. Williams compound condensing engine to the plant of the Chicago Arc Light and Power Company; also a 250 h. p. engine. This makes four engines of 500 h. p. of the Williams type now in service in the Chicago station. The Eclipse company has also placed four 250 h. p. Williams compound condensing engines in service for street-railway duty in Louisville, Ky.

The Davenport (Ia.) Gas Company is erecting a new electric light station to be 90 × 80 feet, divided into a boiler room 30 × 80 feet, and a dynamo room 60 × 100 feet. A new Corliss engine will be belted to a line of shafting operated by clutch pulleys and the dynamos belted to the shafting pulleys. Western electric arc and national alternating incandescent apparatus will be used and is now on the ground, but the order for engine, belts and shafting has not yet been placed—it being the intention to temporarily employ the high speed engines now in service, and Mr. W. Pendleton, the secretary and treasurer of the company, will probably arrange for the other machinery this week.

The Calumet Electric Street Railway Franchise.—At the Council meeting last week Alderman Hummel introduced an ordinance for the Calumet Electric Street Railway, the most extensive and comprehensive in the history of Chicago. It proposes to occupy nearly every important north and south and cross street in that part of Chicago south of Eighty-seventh street with an electric road track, and provides for a loop extending from

Eighty-seventh street along South Chicago avenue and Stony Island boulevard to Sixty-seventh street, bending westward on the latter thoroughfare to Cottage Grove avenue, and thence south on that street to Eighty-seventh street, with a cross-section on Eighty-seventh street. It is thus intended to bring the extreme southern and eastern sections of the city from the Indiana State line and Fernwood up to the gate of the World's Fair. The road will use trolley wires suspended from poles set within the curb line limit of the street and on either side thereof, or from bracket poles of iron placed in the centre of the streets, and will be suspended not less than 18½ feet above the rails. The ordinance, which is accompanied by a petition of the owners of abutting property on the several streets, was referred to the Committee on Streets and Alleys and the petition was referred to the Commissioner of Public Works for verification. The promoters of the road are now the owners of a few miles of electric road in the Calumet region, who are interested in the development of the Chicago Canal and Dock Company's property. At the head of the number are Columbus F. Cummings, Sydney Kent, W. B. Howard, Douglas S. Taylor and F. H. Wetriss.

Clinton, Ia., with a population of almost 16,000, among which are some wealthy mill owners with beautiful residences facing the wide avenues, is about to have an opportunity of appreciating the value and conveniences afforded by an electric street railway line running on all the main streets and especially on the streets now occupied by the old horse-car line, as the State electric company has its tracks nearly completed and six motor cars, each with two 15 h. p. Thomson-Houston motors on hand. The power-house forms an addition to the electric lighting station and adjoining is the new car barn. An 80 h. p. Thomson-Houston generator will be set in the new power-house and belted to an "Ideal" engine. The pole line circuit is being neatly and strongly built. The officers of the new company are, Mr. E. C. Walsh, president; D. Langan, vice-president; A. L. Stone, treasurer; C. C. Coan, secretary, and Gilbert Forney Brown, general manager. These gentlemen have also bought the Thomson-Houston electric light plant in Clinton, and are now operating 145 arc lights, 1,000 alternating incandescent lights and 40 direct incandescent lights, the dynamos being driven by Ideal, Ball and Armington & Sims engines. The main streets of Clinton are excellently paved with fire pressed brick, and when it was known that the new company had secured the right to lay a double track on these streets the old company endeavored to cover the streets with its own tracks. Manager Brown, however, between noon of one day and six o'clock the next morning, had taken up the street pavement and laid half a mile of track, the men working during the night with the aid of electric lights. As the city of Lyon is but two miles distant, and the town of Fulton, Ill., just across the handsome bridge that spans the Mississippi at that point, an extension of the line, to afford good transportation facilities, to both those towns is contemplated. However, as no franchise has yet been granted to any electric company to cover this proposed route, an opportunity is afforded to all to enter the lists.

Electricity Buildings.—The following account has been given of the architecture of the buildings for electrical exhibits at the Columbian Exposition: The south pavilion is a hemicycle or niche, 78 feet in diameter and 103 feet high, which is covered by a half dome, with ribs and decorations in relief, the Corinthian order being carried round the walls. The opening of this niche is framed by a semi-circular arch, the impost of which is supported by four Corinthian columns continuous with the order of the facade. This arch is crowned by a gable or pediment, with smaller gables on the returns, and surmounted by an attic, the whole reaching the height of 142 feet. In the centre, upon a lofty pedestal, is a colossal statue of Benjamin Franklin, whose name intimately connects the early history of the Republic with one of the most important discoveries made in the phenomena of electricity. In order to carry out this idea, on the frieze of the great order around the niche appears the Latin inscription: "Eripuit coelo fulmen sceptrumque tyrannis" (He wrested lightning from heaven, and from tyrants their scepter). In all there are ten spires and four domes which combine to give to the otherwise rigid horizontal lines of the building an effect of lightness and animation in accord, it is hoped, with the purposes of the building. All these towers are composed of one or more orders of architecture, with open arches, interior domes and balustrades. The entablature of the great Corinthian order breaks around each of the pilasters of the four fronts, and above each pilaster in the Attic order is a pedestal bearing a lofty mast for the display of banners by day and electric lights by night. Of these masts there will be in all fifty-four. The whole exterior treatment is carried out strictly according to the formulas of the Italian renaissance, all the architects employed upon the buildings forming the great quadrangle or square having agreed to use a strictly scholastic form of architectural expression, similar in respect to the height of the order, but varying in regard to its character and distribution. In this way, by frequent comparisons of designs, they have endeavored to obtain for the quadrangle, which is the main architectural feature of the Exposition, a unity of feeling, recalling in scale and character the most dignified and important manifestations of architecture obtained in the baths and forums of classic times. According to agreement among the architects of the buildings around the quadrangle the electricity building will, like the rest, have an open portico extending along the whole of the south facade, the lower or Ionic order forming an open screen in front of it. The various subordinate pavilions are treated with windows and balconies. The details of the exterior orders are richly decorated, and the pediments, friezes, panels and spandrils will receive a decoration of figures in relief, with architectural motifs, the general tendency of which will be to illustrate the purposes of the building. It is intended that the friezes of the Ionic order shall bear in each bay the name of a discoverer or inventor associated with the development of the science of electricity, thus setting forth a biographical history of the science. The color of the exterior will be marble, but the walls of the hemicycle and of the various porticos and loggias will be highly enriched with color, the pilasters in these places being decorated with scagiola and the capitals with metallic effects in bronze. In the design of this building it is proposed by the architects to so devise its details and general outlines that they may be capable of providing an electric illumination by night on an extensive scale. It is proposed that the hemicycle or niche, which forms the south porch, shall have either a grand chandelier or crown of lights suspended from the centre of the half dome or shall be provided with electric lights masked behind the triumphal arch which forms the opening of the niche. F. DE L.

KANSAS CITY, MO., July 10, 1891.

The Spencer Printing Company has discarded steam power for electricity and has installed a 4 h. p. motor.

The Missouri and Kansas Telephone Company will not have its new building ready before next spring.

The Postal Telegraph Company is now in larger quarters in the old Board of Trade building, and reports business good.

All the Electric Roads here enjoyed an immense traffic on the Fourth of July, and handled the crowds in a highly satisfactory manner. With all the rush not an accident occurred.

The Common Council is laboring with the electric light problem, with the view of securing better rates for city lighting. There is a strong sentiment that the city is paying too much for light.

The Elevated Railway Company, it is reported, will shortly dispense with its engines and turn the entire system into an electric line. The officials will neither confirm nor deny this report.

The New Private Telephone Plant in the general office building of the Kansas City, Fort Scott & Memphis Railway Company, is giving perfect satisfaction. It is the only thing of its kind in this city.

The Northeast Electric Railway Company opened a beautiful park at the end of its line last week, and as a result is enjoying a largely increased patronage. The park is located in a natural woodland and yields a magnificent view of the river and surrounding country. H. C. E.

SOUTHERN NOTES.

NORFOLK, Va., July 11, 1891.

Atalla, Ala.—The contract for supplying this city with a system of electric lights has been signed.

Tallapoosa, Ga.—The capacity of the Vernon Light and Power Company's electric light plant is to be doubled.

Waynesboro, Ga.—It is reported that Messrs. Corker and Co. are to erect an electric light plant at Waynesboro.

Warm Springs, Va.—It is reported that an electric railway will be built between Warm, Healing and Hot Springs.

Batesville, Ark.—It is stated that a St. Louis, Mo., capitalist contemplates the erection of an electric light plant here.

Rome, Ga.—The contract for putting in a new fire-alarm system here has been let to the Gaylor Electric Co., of Louisville, Ky.

Baltimore, Md.—The capital stock of the North Avenue Electric Railway Company has been increased from $60,000 to $100,000.

Alamo, Tex.—The Alamo Electric Car Company is now running cars over its new route from the post-office to Beacon Hill, San Antonio.

Florence, Ala.—The electric light plant of the Florence Gas, Electric Light and Power Company has been sold to W. P. Campbell for $8,000.

Manchester, Va.—Mr. H. S. Bradley is to furnish electric light and power to private companies, and has asked the city council for a franchise.

Arkansas City, Ark.—It is reported that the Thomson-Houston Electric Company, of Boston, Mass., is to shortly erect an electric light plant here.

Baltimore, Md.—A party of Boston, Mass., capitalists is to improve a tract of land on the Western Maryland Railroad, and establish an electric light plant.

Raleigh, N. C.—Messrs. Hunnicut & Hamlin have received the contract for the erection of the Raleigh Street Railway Company's plant. The cost will be $10,000.

Baltimore, Md.—The board of park commissioners is contemplating the erection of an electric light plant in Druid Hill Park, the finest park in the city of Baltimore.

Schriever, La.—It is reported that Mr. J. T. Moore has let the contract for the erection of an electric light plant on his Waubun plantation, and that work will soon begin.

Shendun, Va.—The electric power plant is nearing completion. Mr. Gilpin, in charge, has 50 men at work, and thinks that inside of two weeks everything will be in operation.

Middlesborough, Ky.—The Electric Light, Heat and Power Company has enlarged its plant. Four hundred incandescent lights have been added, giving it now 1,800 lights.

Brownwood, Tex.—July 9 has been set by the City Council of Brownwood as a day for the consideration of the question of franchises for electric lights and street railways.

Wilmington, N. C.—An electric light plant is to be built at the Hammocks. The Thomson-Houston Electric Company, of Boston, has received the contract for its installation.

Gaithersburg, Md.—The Gaithersburg Mining and Manufacturing Company will soon begin the erection of an electric light plant. The company wishes prices on apparatus.

Houston, Tex.—The Houston City Street Railway Company has purchased 1,600 acres of land near here, and proposes making it an addition and connecting it with an electric line.

Rutherfordton, N. C.—An election will be held here soon to consider the issuing of $25,000 of bonds for the erection of an electric light plant and the construction of water-works.

Houston, Tex.—The Houston City Street Railroad Company, which was reported recently as building 12 miles of electric road, will build 10 miles additional some time during the present year.

Lynchburg, Va.—The contract for building the electric railroad from the Union depot to the Lynchburg and Durham depot has been let to the Edison General Electric Company, of New York City.

Florence, Ala.—W. P. Campbell, as reported last week, has purchased the electric light plant of the Florence Gas, Electric Light and Power Company, and will enlarge and operate the same.

Sutton, W. Va.—The Sutton and Williams River Telephone Company has been incorporated with a capital stock of $10,000. The incorporators are: A. W. Corley, W. S. Nelson, J. L. Gaston and others.

Cumberland, Md.—The Cumberland Electrical Supply Company has been incorporated to establish electrical supply works. The company will make a specialty of manufacturing street railway motors.

Richmond, Va.—President Mason, of the Burton Electric Company, has ordered a set of heaters to be shipped to Boston, Mass., to be used for trial on the cars of the West End Street Railway Company.

Memphis, Tenn.—The contract for erecting the power-house for the Citizens Street Railway Company's plant has been awarded to Messrs. Young and Gettingby. The building will cost from $40,000 to $50,000.

Cornwall, Va.—The hotel now in course of erection here will be lit with electric lights. It is owned by the Irish Creek Mineral and Development Company, of Lexington. The company is to have a 30-room annunciator.

Waynesboro, Va.—The Waynesboro Street Railway, Light and Water Company has received a charter to build a street car line, erect water works and an electric light plant. The capital stock is to be not less than $100,000. The incorporators are: W. N. Fishburne, R. G. Wright, W. B. Gallihar, A. C. Fox, C. V. Sutton, E. G. Fishburne, W. A. Rife, S. H. Lambert, Frank Chew and J. T. Boog.

Atlanta, Ga.—The firm name of Cole, Gentry & Co. will hereafter be known as the C. & G. Electric Company. The facilities for transacting business have been increased. The company is located at 7 North Broad street.

Savannah, Ga.—The Electric Railway Company expected to begin running cars on its electric road about the 15th of July. The dynamo and machinery are being placed in position in the power house at Gwinett and Ott streets.

New Orleans, La.—The Enterprise Construction and Supply Company, Ltd., has been incorporated here with a capital stock of $50,000. The company will buy, sell and manufacture electrical and other machinery and supplies.

La Grange, Ga.—The city council has closed a contract with the La Grange mills to furnish 26 arc lights for the city. The contract was for five years. These lights will be distributed so as to cast the glow of 2,000 c. p. all over the city.

Vernon, Tex.—The city has purchased the electric light plant, water works and ice factory, which was erected last year with the assistance of Galveston parties. The city will now proceed to light the streets handsomely. The price paid was $23,500.

Quanah, Tex.—Judge J. J. Combs has incorporated and chartered a company composed of Fort Worth and other capitalists for the purpose of putting in an electric light plant here. Work will be commenced at once, and the plant will soon be in operation.

Lynchburg, Va.—Mr. C. P. Poole is president, and C. W. Poole, vice-president, of the Southern Electric Company, which was recently organized with a capital stock of not less than $5,000 nor more than $25,000. The company will manufacture electrical apparatus.

Nashville, Tenn.—Sixty thousand dollars' worth of stock and $50,000 in bonds of the Capital Electric Lighting Company have been purchased by the Thomson-Houston Electric Company, of Boston, Mass. The company is now negotiating for the purchase of the entire plant.

Augusta, Ga.—The Thomson-Houston Electric Light Company has been awarded the contract for lighting the Augusta government building for the fiscal year beginning July 1, 1891. Seventy-five 20-c. p. incandescent lights will be placed in the building, at a cost of $900.

Baltimore, Md.—Eight hundred acres of land adjacent to this city have been purchased by the Jarvis-Conklin Mortgage and Trust Company, of Kansas City, Mo., and a syndicate of English capitalists. The company will improve the same and erect an electric light plant.

Richmond, Va.—Mr. W. B. Isaacs, secretary of the Masonic Temple Association; Colonel Bidgood, of the committee, and Mr. W. O. Burton, the contractor, have left for the North, where they go to select chandeliers and combination gas and electric fixtures for their new temple.

Augusta, Ga.—The Murray Hill Improvement Company has decided to use the Thomson-Houston system for its street railway. The power-house will be equipped with both steam and water power. Augusta can soon boast of more miles of electric road than any city in the South.

Tarboro, Va.—A representative of the Edison system has been in this city for a few days in consultation with the Mayor in regard to locating a system of electric lights. The Mayor, as are most of the townspeople, is in favor of lighting the town, and no doubt the lights will be seen shortly.

San Antonio, Tex.—The San Antonio Rapid Transit Street Railroad Company has awarded the contract for track construction and electrical equipment to Mr. L. S. Berg. The company will put in the Thomson-Houston overhead system. W. J. Patterson is president of the company.

St. Ingoes, Md.—During a recent severe thunder storm at this place, lightning struck the Jesuit retreat, instantly killing John B. Lamb, of Boston; Wm. J. Holden, of New York, and James Walters, of New York. Those killed were students of Woodstock Seminary, a well-known Maryland Jesuit college.

Newport, Ky.—The Central Construction Company has been incorporated by W. S. Coon and M. A. Smalley, of Wyandot County, O.; W. M. Taylor, of Philadelphia, Pa., and others. The company will erect electric light plants, construct water-works, etc., and have a capital stock of $500,000.

Washington, D. C.—Andrew Rosewater, Prof. Henry A. Rowland and Lieut. Francis Rawn Shank, of the engineer corps, U. S. A., comprise the committee that was appointed by the President last October to investigate the best system of underground conduits and subways. The board has obtained the opinions of the best electrical authorities in the country, and engineers and municipalities all over the world are watching with interest for the publication of the board's report. The above gentlemen have formed a general idea of the best system for the city, but it will require a great deal of change and adjustment before it is fit in every particular. The plan of campaign that was adopted by the committee is as follows: (1) To inquire into the practicability of putting all kinds of electric wires underground; (2) To ascertain the existing state of affairs in Washington; the location of underground and overhead wires; the franchises of the various companies; systems used by them; working of these systems, etc.; (3) To ascertain the existing state of things in other cities, their experience as to systems used and regulations found necessary; (4) To examine the various projects for subways; to compare the conduits, cables, etc., now in the market, and to select the very best. The first meeting of the committee was held on Jan. 4, 1891, when Mr. Andrew Rosewater was elected president and Lieut. Shank secretary. V. N. B.

ENGLISH NOTES.

(From our own correspondent.)

LONDON, July 1, 1891.

Central London Railway Bill.—Last week the Select Committee of the House of Lords, to which the bill had been referred, declared the preamble proved, and we may therefore conclude that it has safely ridden the storm of parliamentary criticism. The Dean and Chapter of St. Paul's are apparently satisfied that the dome will not collapse, and the Bishop of London this year forbore to attack the measure. In some cases the opposition of landholders near the line of route was appeased by the promise of improvements to their property. Had the Lords passed virtually the same bill last year, a considerable expense would have been saved.

The Government and the Telephones.—About the time of the expiring of the Bell patent in this country in December last the electrical public and more especially the telephone subscribers were eagerly awaiting the decision of the Postmaster-General as to the attitude the government would take in reference to the company. All that could be learned after repeated questioning in Parliament was that the government was anxiously considering the matter, but would not come to a final decision till the expiring

of the further telephonic patent in July. Last week in reply to the question of an honorable member in the House of Commons, Mr. Raikes said that the question was one of great complexity and importance, but confessed that the government had not yet finally decided what course they would pursue. So we still remain in the dark as to the future of telephonic London. This would not be so regrettable if the uncertainty would induce the National Company to improve the service here, which compares very unfavorably with that of many towns in the north of England and Scotland, where complete metallic circuits are in vogue.

The City Lighting.—On Wednesday last a preliminary trial of the electric light was initiated in the district assigned to the Brush Company, being the centre of the three districts into which the city is divided. The primary object of the partial lighting on Wednesday was to enable the city authorities to ascertain the most suitable form of lamp for street lighting. The current is supplied from an original Brush machine, refitted with a laminated armature. The machine runs at 1,200 revolutions and supplies a current of 12 ampères at a pressure of 40 volts to each of the 26 lamps erected in Queen Victoria street. The lamps are of 2,000 c. p. placed 120 feet apart on poles 19 feet high fitted with adjustable steps to enable the lamps to be trimmed. The arcs are variously inclosed in lamps with panes of molded, frosted and ground glass, in order to ascertain which form gives the maximum distribution with a minimum absorption of light. Judging from the comments in the daily and technical press the experimental lighting has given almost universal satisfaction, and doubtless the public will welcome the time when the lighting will be extended all over the city.

Answers to Correspondents.

Questions to be answered in this column must be of general electrical interest, and must be accompanied by real name and address as a guarantee of good faith. No notice will be taken of questions regarding apparatus unless enough details are given to permit a definite answer, and no dynamo or motor designing will be done.

Medical Coils.—Where can I obtain directions for constructing a medical coil? A. F. T.

We advise you to read "Electrical Instrument Making for Amateurs," by Bottone, for sale by The W. J. Johnston Company, New York City.

Coney Island Electric Road.—Can you inform me in your next issue if there is an electric railway between Brooklyn, N. Y. and Coney Island? What system is used? G. A. W.

An electric railway runs from Prospect Park, Brooklyn, to Coney Island. The Thomson-Houston system is used.

To Make an Induction Coil.—Will you please describe in your correspondents' column how to make an induction coil, giving the size of wire, etc., etc.? I have failed in every one I have made. A. E.

What the details for wire, etc., shall be depends upon the size of the coil required. We would refer you to THE ELECTRICAL WORLD of May 3, 1891. The cause of your failures is most likely bad insulation. Well insulated wire must be used and as each layer is wound a heavy coating of shellac must be put on. Thin cambric muslin saturated in shellac or hard copal varnish, placed between each layer of wire or the secondary coil should render the insulation adequate.

Small Motors.—Will you please answer through your "Answers to Correspondents" a few questions? (1) In a simple electric motor, similar to those used for winding clocks—the armature consisting of six pieces of iron, mounted on a brass hub so as to rotate close to the poles of three electromagnets—is there any loss, and where, or is the size only objectionable? (2) In a late number of your paper I noticed a query in regard to impedance and resistance coils. Please explain difference in winding. (3) In the best shunt-wound motors what is the difference in resistence between the armature and field? (4) Are the armatures of 50-volt constant-potential motors wound to sufficient resistance to allow only the necessary number of ampères to pass or is external resistance placed in series with the armature? G. G. L.

(1) Small motors are apt to be inefficient unless designed with great care, many factors of inefficiency attending the limitations of small motors that do not appear in larger design. Both in small clock-winding motors and similar diminutive apparatus electrical efficiency is not much sought. For instance, no one has measured the hysteresis loss of an electric bell. (2) Resistance coils are wound with wire which has been beforehand doubled back upon itself so that the magnetism of the current may not produce impedance or inductive resistance. An impedance coil consists of a soft iron core wound with many turns of wire. It is also called a reactive coil. A resistance coil needs no iron core. (3) It depends upon what machine you have reference to. It will be something between the ratios of 1 to 200 and 1 to 400 for an ordinary shunt dynamo, the larger figure representing the field resistance. (4) The only external resistance may be that of a regulating rheostat. The resistance of the machine is such as to allow the required current to pass when running upon a circuit of standard electromotive force. The back E. M. F. renders other resistance needless.

News of the Week.

THE TELEGRAPH.

Vermont Extensions.—The Green Mountain Telegraph Company has extended its line to Chester, which with the new stage route to that place will provide for increased business between the two towns.

Lynn, Mass.—The Lynn District Messenger Company, which suffered severely in the great fire of November, 1889, will soon resume business. It has been purchased by the Postal Telegraph Company and will start with 75 call boxes.

New Western Lines.—The Postal Telegraph Company is increasing its facilities between Kansas City and Chicago, by the stringing of two copper wires from Kansas City to St. Joseph, along the Maple Leaf route, to connect with the wires over the same route from here to Chicago.

An Interesting Telegraph Company Deed of Sale.—The deed of sale of all the telegraph lines of the Baltimore & Ohio Railroad Company to the Western Union Telegraph Company for the sum of $5,000,000 was filed last week in the county recorder's office. This sale took place five years ago, when the Western Union Company absorbed the Baltimore & Ohio line, and in order to make the sale valid a copy of the transfer deed was taken in every county recorder's office through which the Baltimore & Ohio telegraph line ran from Baltimore to Chicago. The line runs through over one hundred counties in Maryland, Virginia, West Virginia, Ohio and Illinois. The original deed was started along the line from Baltimore five years ago, just after the sale was made, and it was pigeon-holed from one to two months in each county recorder's office. The deed covers about a dozen pages of typewritten matter on legal cap, and sets forth that the payment of $5,000,000 to the Baltimore & Ohio Company is to be made in the capital stock of the Western Union—50,000 shares at par value of $100 each. The deed is wrapped in black paper and shows but little wear of the five years it has been traveling. The document bears the names of the 100 county recorders. It has now reached the end of its route, and will be deposited in the strong safe at the Western Union office.

Rapid Telegraph Company Sale.—The confirmation of the sale in New York City several weeks ago of the property of the American Rapid Telegraph Company in the Chicago court is only part of a series of legal steps to ratify the sale taken in the various States through which the telegraph line runs. The company was organized about 12 years ago, with the purpose of exploiting one of the numerous patents for rapid automatic telegraphing. It failed to coin a fortune, and several years ago was placed in the hands of a receiver, who leased the line for operating purposes to the Western Union Telegraph Company. Officers of the latter company deny that the company was interested in the sale of the Rapid Telegraph property. The bondholders bought it in by agreement, and will try doubtless to sell it to the Western Union.

Postal Telegraph Fight at New Orleans, La.—The fight of the Postal Telegraph Company with the City Council to obtain permission to bring its wires into the business portion of the city culminated last week, when the Mayor personally superintended the cutting down of several poles of the company. The telegraph company offered to bury its wires from the outlying districts under ground, but the Council insisted that the wires should be strung from iron towers which another corporation had obtained the right to erect to suspend telegraph and other wires. The Council is believed to have acted from pressure from the latter company. The telegraph company, however, began the erection of poles in the prohibited district, and the Council ordered the Mayor to remove them. A Postal Telegraph representative protested with the Mayor against this action of the Council, but Mr. Shakespeare, while he expressed sympathy for the company, and thought they ought to have full entry into the city as other companias, and not to be made pay tribute to the tower corporation, said he had no option in the matter but to obey the orders of the Council, and fortwith proceeded to cut down the poles. Lawyer Beckwith, for the Postal Company, says the Mayor should have taken advice before he enforced the orders of the Council, and intimates that the city will be held responsible. The Mayor and City Attorney have had a long conference on the matter. The public sentiment is overwhelming that the Postal should have equal privileges with other companies, especially as its proposition to place its wires underground covers the objection to the erection of poles. The Mayorsaid he believed the Council were acting in the interest of monopoly.

THE TELEPHONE.

Clarksburg, W. Va.—Telephone communication between Fairmont and Clarksburg has been opened.

Rockford, Ill., has suffered greatly from the stormy weather lately. Twelve telephones were burned out last week.

New California Lines.—The new telephone line recently constructed to Folsom has been extended to Orangevale.

Crystal Falls, Mich., is to be connected to Superior this summer if the Council passes upon the wishes of the majority of the citizens.

Telephone Cables in Berlin.—It is estimated that the underground telephone cables of Berlin are sufficient to meet the requirements of 30,000 telephone subscribers, the present total being about half that number.

Eufaula, Ala.—A representative of the Bell Telephone Company and Mr. John Thomas have been canvassing the town for subscribers to the proposed telephone exchange. As soon as 40 subscribers are secured work will commence.

Fond du Lac, Wis., is soon to have the advantage of better telephone facilities. The construction crew of the Wisconsin Telephone Company began work last week on a new line from Milwaukee to Appleton. Two complete circuits of copper wire will be strung. New poles will be set, and by the aid of the long-distance phones now in use in each central office, conversation can easily be carried on.

To Fight the Telephone Company.—A lively fight has begun between the druggists of Baltimore, Md., and the Chesapeake & Potomac Telephone Company, owing to the latter's increasing the annual charges and requiring patrons to sign an agreement not to permit outsiders to use their telephones without paying a certain charge for every message. The leaders in the fight against the company have issued a protest, which has been signed by many physicians and druggists. They threaten to take out their telephones unless the company reduces its charges and withdraws the objectionable regulations.

Des Moines, Ia.—The telephone committee of the City Council held a meeting at the City Hall last week and drafted an ordinance to regulate the telephone companies in Des Moines. For the past seven years the American Telephone Company has operated in Des Moines without being subject to any regulations whatever. Until within the past year or two the city paid about $700 a year for the use of the city telephones. The ordinance passed by the city years ago was not accepted by the telephone company and consequently was not in force. Some months ago the City Council passed an ordinance requiring the company to allow the city the use of seventeen telephones free and pay 3 per cent. of its earnings into the city treasury as a bonus for the use of the streets. This ordinance the telephone company refused to agree to. The city threatened to force the company to place its wires underground unless the ordinance was accepted, but it appears that it cannot lawfully do this unless it compelled all the companies to put wires underground. The committee agreed on a compromise ordinance, which provides that the company allow the city the use of twenty telephones, give it a receipt for the $1,000 bill the company now has against it for use of telephones, and agree to give the city a 25 per cent. discount on all telephones in addition to said twenty that the city may need in the future. It is understood the telephone company will accept this ordinance and the committee is of the opinion that the Council should pass it.

THE ELECTRIC LIGHT.

Fairmount, Minn., has voted for electric lighting.

Crown Point, Ind., is to have electric lights this summer.

Woodstock, Ill., is agitating the electric light question.

Wahoo, Neb., is to have a municipal electric lighting system.

Tarkio, Mo., is to greatly enlarge its electric light plant this year.

Albia, Ia., has decided to erect an electric light plant. Work will be begun before fall.

Collinwood, O., is receving bids for electric street lighting for seventy-five 2,000 c. p. arc lamps.

Coldwater, Mich., has received a bid for its proposed plant from the Brush Electric Light Company.

Wheeling, W. Va.—The Ætna mill will be lighted with 40 electric arc lights. The company will put in its own plant.

Butler, Mo., is receiving bids for a municipal electric light plant to have a capacity of twenty-five 2,000 c. p. arc lamps.

Taylor, Tex.—A Dallas firm, represented by Mr. A. B. Williams, is figuring with the City Council for an electric light plant here.

The Troy (N. Y.) Electric Light Company, including the plant on River street, has been purchased by Mr. A. M. Brady, of Albany, for $90,000. Mr. Brady was the sole bidder.

Indianapolis, Ind.—Although the city advertised some time ago for bids for municipal lighting, it has as yet received no proposals. The time for receiving bids, therefore, is indefinitely postponed.

Newport, O.—The electric light plant is at last completed, and the city is now brilliantly illuminated. The people are highly pleased, and pronounce the system as satisfactory, both financially and otherwise.

Wheeling, W. Va., has sent out a committee to visit Pittsburgh, Pa., for the purpose of inspecting the lighting systems of the latter city with a view to settling the hackneyed electric light question of Wheeling.

Pittsburgh, Pa.—The fourth brewery in Pittsburgh that has contracted for lighting by incandescent lamps has just placed an order with the Edison office at Pittsburgh for a 200-light plant for the Eberhardt & Ober Co.'s establishment.

Quincy, Ill.—The time for opening bids recently reported to have been called for has been placed at July 20, 1891. The bids call for electric arc lighting for the city of Quincy, to begin on August 27, 1891, and to be in operation for one year thereafter.

Ebensburg, Pa.—A new feature in the mountains is a lighting station. A company formed by Mr. E. B. Cresswell, of Ebensburg, has just closed a contract with the Pittsburgh office of the Edison General Electric Company for an 800-light station.

The Puyallup (Wash.) Light and Water Company's plant has been transferred to the Tacoma Light and Water Company. The consideration named is $112,500, and the sale includes quite attractive property with the waterworks system and electric light station.

Rochester, N. Y.—The Board of Managers of the State Industrial School recently advertised for bids for constructing an electric light plant for the institution. All the bids received were rejected as too high and otherwise unsatisfactory. A re-advertising has been ordered.

Indianapolis, Ind.—The Brush Electric Light Company has filed its bill for electric lights—119 lamps at $8.75 per lamp per month since the first of January—amounting to $6,083.77. The 2½ per cent. allowed the city amounts to about $156. The Indianapolis Gas Company's bill for June is $3,299.30.

Butler, Pa.—The Standard Plate Glass Company, of Butler, Pa., at its last meeting seriously took up the question of lighting its establishment by electricity. A number of bids were received, but the contract was given to the Pittsburgh agency of the Edison General Electric Company for a 500-light installation.

The Peninsular Electric Light Company held its first meeting recently in Detroit, Mich. The following officers were elected: R. T. McDonald, of Ft. Wayne, Ind., president; J. L. Edson, vice-president; Edward Hathorne, of Boston, Mass., secretary and treasurer, and H. L. Wilton, formerly of the Brush Company, assistant secretary.

No Gas.—A San Francisco building gives emphatic notice *"There will not be a single gas pipe used in this building."* An isolated plant is contemplated. The electric light fixtures throughout the building are very handsome, and the circuits are run in such a way as to have far better control of illumination than would be possible with gas or the ordinary circuit running.

Electric Lighting in Canada.—It has been decided to light by electricity the workshops and yards of the Intercolonial Railway at Moncton, N. B. The managers of the Intercolonial, after having had the different systems of electric lighting studied by its chief electrician, Mr. A. A. Dion, has adopted the Wood system of arc lighting, and has given the contract to Mr. A. J. Corriveau for his company.

Waterville, Me.—At a recent meeting of the city council it was voted to build a municipal electric light plant, and for this purpose $20,000 was appropriated by the council. Since the council meeting the committee appointed for the purpose has contracted for an electric light plant of sufficient capacity to furnish all the electric light, both arc and incandescent, needed for lighting the city. It is stated that work on the plant will be commenced immediately.

The Montreal Citizens' Committee for the Reception of the National Electrical Association, which meets in Canada in September, held a meeting at the Windsor Hotel in Montreal last week. Professor Bovey presided, and the chairmen of the several sub-committees handed in their reports, which proved highly satisfactory. Some 16,000 feet of space has now been applied for by intending exhibitors. It will be one of the greatest exhibitions held in Canada.

Independence, Kan.—The City Council met in regular session last week, and received bids for street lighting. The local electric light company made the following bid: Ten lights at $9 per light, 15 lights at $7.75, 20 lights at $6.50, and 25 lights at $6. The gas company made a bid of $7.50 per gas lamp for one year, and also offered to make a bid for lighting the city with electricity. The matter was referred to the light committee, which will report at next week's meeting.

Millville, N. J.—The Millville Schuyler Electric Light Company, of which Mr. H. S. Foster is manager, has just entered into a contest for legal rights in that city. A new company has been started whose charter members are stockholders in the gas company now furnishing gas lights in the city. This gas company also controls the city water-works, and although paying taxes on a capital of only $400,000, it is stated that the plant could not be purchased for less than $3,000,000.

Reading, Pa.—The contract for the rebuilding and the equipment of the plant of the Reading Electric Light & Power Company has been awarded to the Falls Rivet & Machine Company, of Cuyahoga Falls, O. The motive power will be supplied by a 1,000 h. p. engine furnished by the Hamilton Corliss Engine Company, of Hamilton, O. A local paper in referring to the contract says: "Mr E. L. Babcock, president of the company, has been in the city completing the details of the contract and perfecting arrangements for the execution of the work. Mr. Babcock's established reputation as a mechanical engineer, together with that of his company for capacity and responsibility, affords a guarantee that when completed

the equipment of the Reading electric station will be what it is proposed to make it—one of the most perfect in the country."

Transportation Rates to the Montreal Convention.—Mr. Corriveau, of Montreal, has had a conference with Mr. Edgar, general passenger agent of the Grand Trunk, Mr. McNicoll, general passenger agent of the Canadian Pacific, and Mr. Milloy, traffic manager of the Richelieu and Ontario Navigation Company, to arrange special rates for those going to the approaching Convention of the National Electric Light Association. The prospects of the Convention are very bright; applications for space have been so numerous that in order to accommodate all exhibitors it is thought the vacant lot adjoining the rink will be secured and temporarily inclosed for the occasion.

THE ELECTRIC RAILWAY.

South Orange, N. J.—It is reported that Mr. John Radel is not to sell his tramway line and that the road is to be equipped with electricity.

Vancouver, B. C.—The Vancouver Electric Railway and Light Company, Limited, is doubling the size of its power and car houses, and expects to have them finished in about another month.

Du Bois, Pa.—The Du Bois Traction Company has signed a contract with the Edison General Electric Company at Pittsburgh for the equipping of its line, consisting of four cars and power station; the motors are to be of the new Edison single-reduction type.

A Blue Island Road.—A company has been formed for the purpose of building a railroad from Blue Island east to some point on the Michigan Central R. R. The capital stock of the company is $25,000. J. B. Crooker, one of the directors, represents the interests of L. F. Menage, the owner of the Morgan tract. Much of the necessary right of way has been secured.

A Proposed Westinghouse Road.—It is announced that the Westinghouse Electric and Manufacturing Company has signed a contract amounting to $110,000 for building and equipping an electric railway, 14 miles in length, from Tiverton Four Corners to Seconnet, R. I. It is also said that the Westinghouse Company is to take $35,000 of the stock of the railway company in part payment.

McKeesport, Pa.—The McKeesport & Reynoldton Passenger Railway Company which has been operating by horses for the past five years, has just closed a contract with the Edison General Electric Company at Pittsburgh, for the equipping of its power station with two 125 h. p. generators and 16 motors for eight cars. The motors are to be of the new Edison single-reduction type.

The Pittsburgh & Birmingham Traction Road.—The Short Electric Railway Company, of Cleveland, O., has a contract with the Pittsburgh & Birmingham Traction Company for 20 motor cars, 18 of which are already equipped, and 16 of these were put in service at the opening of the road. Of the 30 cars which this company will put into regular service, 20 instead of 10, as was stated in a recent issue, will be equipped with Short apparatus.

First Thomson-Houston Railway in Michigan.—The Marquette City and Presque Isle Railway Company, which is operating the Thomson-Houston system, has recently been put in operation. This line comprises three miles of track, and is at present operating three motor cars. This is the first road in Michigan equipped by the Thomson-Houston Electric Company, and if its first day's operation is any criterion for what is to follow, it will be eminently successful.

Mount Vernon, N. Y.—The committee of the Village Trustees appointed to draft the provisions of the franchise granted to the Westchester Electric Railway Company has been advised to act under the supervision of the village counsel. The company proposes to construct and maintain an electric railway that is to run from the Hudson River at Yonkers, N. Y., to the Sound at New Rochelle, and it is proposed that the franchise shall stipulate its forfeiture should the needs and safety of the public be disregarded by the company.

From Jersey City to Newark.—President Thurston, of the Jersey City & Bergen Railroad Company, is authority for the statement that his company and the Rapid Transit Company, of Newark, have been in conference, with a view to establishing an electric road between Jersey City and Newark. He holds out hope of the scheme coming to fruition. If it is built a capital of $25,000,000 will be engaged. The line, when it is established, will utilize the line of the Rapid Transit Company in Newark and Mr. Thurston's lines in Jersey City.

A New Pittsburgh (Pa.) Motor Manufacturing Company.—The new Birmingham, Knoxville and Allentown Traction Company, of which Mr. H. Sellers McKee is principal director, is to manufacture electric railway motors and supplies upon an extensive scale. Mr. McKee is largely interested in a large railway syndicate, whose field of operations embraces many cities throughout the country. It is the supposition that the charter has been made to cover the manufacture of motors, with a view on the part of the managers of the syndicate to manufacture at Pittsburgh all appliances needed for the different roads operated by it.

Brooklyn, N. Y.—George W. Van Allen, president of the North Second Street Railroad, sent a communication to the Board of Aldermen last week asking permission to extend the tracks of that railroad from Metropolitan avenue and Fresh Pond road through Fresh Pond road to Jamaica turnpike, to Market street, to Liberty avenue, to Rockaway avenue, to Parkway and across the Parkway to Canarsie landing. The company also desires to lay tracks from Rockaway and East New York avenues to Broadway, and from Rockaway and East New York avenues to Ocean avenue, near Prospect Park and the town of Flatbush. The company asks permission to use either horse power or electricity. The communication was referred to the Railroad Committee.

The New South Harvey (Ill.) and Harvey Electric Road will start at Homewood Station, on the Illinois Central, run east to Ashland avenue, thence north through South Harvey on Ashland avenue to 164th street, and east to the steam-railway depot in Harvey. The road will begin operations with 12 passenger cars and two electric motors. The cars will run every half-hour during the day and every 10 minutes in the morning and evening during the rush trips. The object of the line is to connect South Harvey with Homewood and Harvey, each of which places is about a mile and a half distant from it. Over half the stock has been subscribed and the principal part of the right of way has been secured. Estimates have also been made on the construction of the line and on the building of the cars.

The Sewickley (Pa.) Electric Company did a clever piece of work a few days ago in the removal of its lighting plant from temporary quarters which had been occupied for some time to its new power house one mile distant. To the end that the patrons of the company might suffer no inconvenience from the removal, it was decided that everything must be done between the hours of sunrise and sunset. Accordingly, work was begun at dawn, even before the engine had cooled off sufficiently to be handled with ease, and the work was pushed diligently forward all day. The engine, one 750-light incandescent dynamo and one 40-light arc dynamo were in place in the new building by noon, and afterward, between that time and seven o'clock, were erected on the foundations prepared for them. The managers of the light company were well pleased over the rapid manner in which the change was made, and few residents of the town were aware of the fact that it was being carried out at the time.

The Cicero & Proviso Electric Railway Company, of Chicago, will build a branch road on West Twelfth street, running from West Fortieth street to Desplaines avenue, before winter. The company will also have in operation within the next sixty days a track on West Forty-eighth street from Madison street south to Hawthorne, the location of Ed. Corrigan's famous race track. The rights of way for both of these roads have been secured, and there is nothing to prevent the early completion of these lines. The company is already laying tracks on Desplaines avenue to South Twelfth street, and will have that branch of the road completed before long. The other road on Twelfth street has all been contracted for, and active building operations will be begun as soon as the supplies can be brought on the grounds. The West Forty eighth street line is the one that will be pushed most rapidly, however, so as to be in running order before the racing season closes. The steam railroad is beginning to feel the force of the competition which the electric road is creating, and has added seven trains daily each way to its suburban system so as to meet more successfully the inroads of the electric line on its patronage. The new trains will all run over the main line and will be of special value to the cemeteries. The result of this improvement is already having its effect in increasing inquiry and strengthening prices for property in this region.

EDUCATIONAL NOTES.

Electrical Engineering at Michigan University.—During the past year 60 students were enrolled in the electrical engineering course at the University of Michigan, which is, as is well known, under the direction of Prof. H. S. Carhart. It will be remembered that this department of the University is only in the second year of its existence. The facilities for instruction will be greatly increased during the summer by the addition of a number of instruments of precision from abroad, including two more of Sir William Thomson's electrical balances, and by a 300-light alternator with exciter and converters. A compound wound generator will also be purchased, and the power plant will be enlarged by the exchange of the present steam engine for a larger one of 50 h. p. The permanent force of instructors has also been increased, so that at the opening of the next year in October the facilities for instruction will not be behind those of the other departments of the University.

PERSONALS.

Mr. Ambrose Davenport, of New York City, has been elected treasurer of the Hunt Engineering Company.

President McMillan, of the Detroit Electrical Works, was in Boston last week on his way to Bar Harbor, where he will spend a few days.

Mr. Charles G. Blandy, for some time past with the Columbia Electric Company, of St. Paul, Minn., has become associated with Mr. S. Shapleigh, of Philadelphia, Pa. Mr. Blandy has had a long experience in the promotion of successful electric light and power companies, and is well known by the electrical fraternity.

MISCELLANEOUS NOTES.

Air Brakes on Electric Street Cars are to be introduced on Pittsburgh, Pa., roads.

An Electric Billiard Table.—Mr. Lyman A. Spaulding, of Chicago, Ill., has just patented an arrangement for attachment to a billiard table, in which an electric push-button is arranged under the cloth in such a way as to respond to the weight of the ball, and is fitted with an indicator by which the action of the push-button is registered.

The United States Patent Guaranty Company, of which ex-Senator Ingalls is president, has just been organized in Washington, D C. It proposes to treat property in patents in much the way that the title insurance companies treat property in real estate. Incidentally this organization will undertake the capitalization and exploitation of valuable patents, in regard to which it will occupy the relation of trustee. As a patent trustee the Guaranty Company will be in a position to protect the smallest minority interest and insure its rights *pro rata* with the majority interests.

Electrical Progress in Tokio, Japan.—The Municipal Gas Lighting Plant of Tokio is to be replaced by electric system, an arc light plant being used. A special committee of the aldermen has been ordered to examine the different systems and to report which one is considered the best for street lighting. The new temporary parliament house is to be lighted by electricity. It will be remembered that the destruction of the old parliament houses not long ago, which was caused by fire, was reported to have been due to a cross in the electric wires, but as this report was disproved to the satisfaction of the authorities the new building will be lighted by the same means. About 1,000 incandescent lamps will be required in this building.

St. John, N. B.—St. John is now probably one of the most brilliantly lighted cities in the Dominion (owing in a large measure to the interest created in electrical work by the electric exhibition recently held in that city), there being five of the finest central stations of electric light companies in the city running the Edison, Thomson-Houston, Fort Wayne and Brush systems. The competition between these companies brings the light within the reach of the citizens generally, and very many of the property holders have therefore indulged very lavishly in electric light. In addition to this, the corporation of the city is now running electric lights of its own in the North End, Brush plant, and Messrs. D. W. Clark & Son are running the Brush system at the West End, and the New Brunswick Electric Light Company (Fort Wayne system) has completed arrangements for lighting the East End. The citizens of St. John are endeavoring to make their "Canada's International Exhibition" of this year an unprecedented success. Exhibitors have already applied for space, including a number from the United States, England, Germany and Italy. Arrangements are being made whereby the Machinery Hall will be made far more attractive than at any previous exhibition, as it is expected that nothing but machinery in motion will be shown here. A number of the different processes of manufactories, including some specially attractive novelties in the manufacturing line, will be shown. Arrangements are also in progress for a special electrical display, and it is expected that most of the novelties in this line will be represented. Ira Cornwall, of the St. John Board of Trade, can give full information.

Industrial and Trade Notes

The Wainwright Manufacturing Company is bringing out a new feed-water heater, which the company has every reason to feel proud of and which is meeting with the hearty approval of steam users everywhere.

The Manufacturers' Electric Company has awarded the contract for the construction of its pole line and other work to Chas. H. Shay & Co., the electrical contractors and pole line builders of 706 Walnut street, Philadelphia.

The Pettingell-Andrews Company, of 192-202 Summer street, Boston, announces that it has secured the controlling interest in one of the largest incandescent lamp factories in the country, and is now prepared to furnish incandescent lamps of any candle power or voltage and for any socket.

Mr. H L. Chapman, of White Pigeon, Mich., has issued a circular describing the positive action friction clutch, of which he is the inventor. This clutch is adapted for driving forge fans, tricycles, lawn mowers, circular and scroll saws, emery wheels, lathes, and other hand and foot power machines.

The Taylor Primary Battery.—A new battery which Messrs. Taylor & Son, of 39 Dey street, New York, are about to place on the market, and which was noticed in the last issue of THE ELECTRICAL WORLD, has an E. M. F. of 1.4 volts instead of one-quarter of a volt, as was formerly stated. The capacity of the cell is said to be 40 ampère hours.

The Germania Electric Company, manufacturers of the Schaffer incandescent lamps, and licensees of several foreign electrical companies, of 50 State street, Boston, Mass., has opened a New York office at 63 Broadway. Mr. Peter Claus, formerly connected with the exploitation of the Continental and Easton dynamos, will have charge of the New York office of this company.

Messrs. W. R. Ostrander & Co., 195-197 Fulton street, New York, have issued the eighth edition of their revised catalogue, which includes a great variety of electrical apparatus, such as gongs, bell hangers, hardware, electric bells and supplies, annunciators, etc. It is handsomely illustrated, and contains complete descriptions and price lists of all the apparatus. A good index adds to the value of the pamphlet, which contains a total of 112 pages.

Queen & Co.'s Tachometers.—This company is just now making a specialty of tachometers for indicating the speed of engines, dynamos and motors. These instruments are quite as essential to the economical operation of a plant as ammeters and voltmeters, which fact is being demonstrated by the greatly increasing demand for them. By means of a tachometer it is possible to tell at a glance the exact rate of speed at which an engine or dynamo is running. For portable work a special instrument is made which takes up but little space and can easily be carried about. This tachometer is as accurate in its readings as the larger type mounted on a strong base and designed for permanent attachment in the engine or dynamo room.

dia Rubber & Gutta Percha Insulating Company has issued a catalogue printed in colors, giving complete descriptions and illustrations of the Habershaw wires. The pamphlet also contains fac-simile letters from users of Habershaw wires, testifying as to their merits. Not the least interesting part of the catalogue is the list of prominent installations in which Habershaw wires have been used, since in this list is included a very large number of the United States war ships recently equipped with electrical apparatus and many of the first-class passenger steamers plying between ports on the Atlantic seaboard. On the last page of the cover appears the heading, "List of Places where Habershaw has Failed," and, as might be expected, the remainder of the page is a blank.

Truex & Vail report that the following railroad companies and electric light stations have adopted their swinging ball lightning arrester since they have been handling it: The Ball Electric Light Company, of New York; the Hamilton & Lindenwald Electric Railroad, Hamilton, O.; the Federal Street & Pleasant Valley Railroad, Allegheny, Pa.; the Edison Company, Paterson, N. J.; the Danville Gas and Electric Light Street Railway Company, Danville, Ill.; the Cincinnati Electric Light Company, Cincinnati, O.; Porter Rawlings, Helena, Ark., electric light station; the Canton Electric Light and Power Company, Canton, O.; the city of Ottawa, Ill., on its local plant; the Jenkintown Electric Light Company, Jenkintown, Pa.; Utica & Mohawk Railroad, Utica, N. Y.; the Lindell Railroad Company, St. Louis, Mo., and the Edison Electric Light Company at New Brunswick, N. J.

Improved Street Car Journal.—Some experiments have been made on a street car running on the Steinway & Hunter's Point Railroad, Long Island City, N. Y., fitted with a new type of journal, the invention of Mr. Peter Sweeney. The device has for its object the reduction to a minimum of the friction, and a thorough lubrication without loss of the lubricant. The body of the car is supported upon an axle box consisting of a cast shell, with the exception of a thin plate and cover cast in a single piece and nearly semi circular in shape. Inside of this main box is arranged a wheel supported by an axle, the ends of which turn in boxes of babbitt or other metal. The wheel is cast with an annular recess in which the end of the car axles receives its bearings and is hollowed or concaved around the hub to lighten the weight and is also provided with a strong peripheral band, shrunk on to give additional strength. The invention is applicable to horse, cable and electric car service.

The John Roebling's Sons Company, of Trenton, N. J., has just shipped two heavy submarine cables to the Pacific Postal Telegraph Company, at San Francisco, the length of the cables being 10,560 feet and 17,000 feet respectively. Each contains ten gutta percha insulated conductors composed of three No. 18 wires, the gutta percha being nine-thirty-seconds of an inch thick. The shorter cable is armored with 18 No. 2 galvanized steel wires and the larger one with 18 No. 3 wires. They are to be laid from Oakland Mole to Goat Island, and from there to San Francisco. Heretofore the cables in use were found not to be heavy enough to avoid injury caused by anchors fouling them. It is estimated that the great strength of the armor on the new cables will be sufficient to avoid any damage being done under similar circumstances. The Roebling Company has machinery capable of making armored cables of any length, or of making the heaviest shore end cables. The necessary tanks for testing under water are a part of the appliances, and the testing apparatus is of the highest type used for testing ocean cables. Preparations are now being made for the construction of a cable 95 miles in length, the total weight of which when armored will be over six hundred tons.

Prominent Asbestos Manufacturers Consolidate.—The H. W. Johns Manufacturing Company and the Chalmers-Spence Company, New York; the Asbestos Packing Company and Chas. W. Trainer & Co., Boston, and the Shields & Brown Company, of Chicago—the five largest asbestos manufacturers in the

United States—have formed a corporation under the name of the H. W. Johns Manu facturing Company. They will control most of the output in their line of business. The officers of all the companies and their chief employees will remain with the new concern, which will thus have the advantages of their combined skill and experience. H. W. Johns is the president; R. H. Martin, formerly president of the Chalmers-Spence Company, the new vice-president; C. H. Patrick, treasurer, and G. P. Erhart, secretary, both of the last two named having previously been with the H. W. Johns Manufacturing Company. The consolidation, which was effected July 1, was made, it is stated, to reduce the cost of asbestos manufacture and to save other expenses. The company promises to give its customers the benefit of the economy which will thus be practiced. The new H. W. Johns Manufacturing Company will have its headquarters at 87 Maiden lane, New York City. There will be branch offices in Boston, Chicago and Philadelphia, and agencies in London and elsewhere abroad.

The Electric Car Brake Safety Attachment Company, with offices in New York City, has recently been incorporated to exploit a new electric-car brake, for which is claimed great simplicity of construction and ease of management. The device was recently tested on an experimental car at the factory of the Thomson-Houston Electric Company, at Lynn Mass., and its feasibility and success was well demonstrated. With the new brake the old trouble of caring for left and right handed brakes is obviated, as only the right hand is necessary for its operation. One movement of the controlling handle or lever instantly applies the brakeshoe and cuts off the current, and our representative who attended the experimental trip, saw the loaded car stopped upon a level grade within a few feet, and within two car lengths while rushing down a 14% grade at the speed of 25 miles an hour. The company has met with many testimonials from those who have seen the work of the new brake. The officers of the company—all well-known railway officials—are: R. Tenbroeck, president, general eastern agent of the Union Pacific Railway; Milton C. Roach, vice-president, general eastern passenger agent of the New York Central Railway; Henry B. Jagoe, secretary, general eastern passenger agent of the West Shore Railroad Company, and William T. McBride, treasurer and manager. Mr. McBride, who is now stopping at the Quincy House in Boston, informed our representative that his company was willing to apply the attachment on the cars of other roads, and to test it upon request, at the expense of his company.

OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS.

U. S. PATENTS ISSUED JULY 7, 1891.

455,298. Electric Locomotive; Norman C. Bassett, of Lynn, Mass., Assignor to the Thomson-Houston Electric Company, of Connecticut. Application filed Oct. 30, 1890. The combination in an electric locomotive comprising an electric motor extending from axle to axle of the truck and having a spring support upon each of the said axles, with a frame rigid with the axles, and a third spring support for the motor thereon substantially in line with the armature.

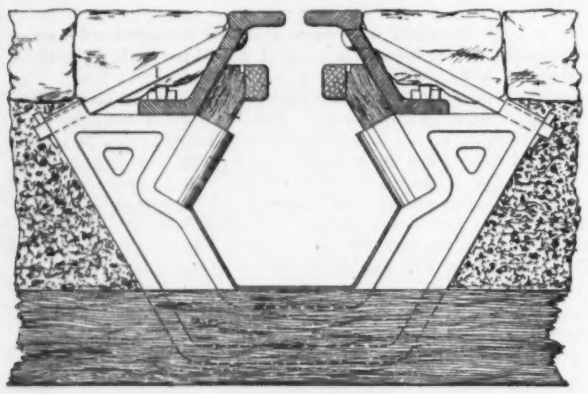
455,316. Annunciator; Manias Garl, of Canton, O. Application filed Sept. 26, 1890. This invention comprises electro-magnets and a frame in which said magnets are supported, an armature provided at one end with a spring, the screw supported in the frame and adjacent to the armature spring, a needle shaft having a needle, a drop mounted on the needle shaft and provided with an extension and a notch adapted to be engaged by the armature, and means for elevating the drop when released by the armature.

455,320. Telegraph-Key; Robert W. Green, of St. Thomas, Canada. Application filed Feb. 10, 1890. The combination, with a key lever and a contact arm of a sliding contact strip of said lever backed by a spring, a latch lever for holding said strip in an advanced position, a rod connected with the latch lever and passing through the key-knob, and a lever for withdrawing the sliding contact strip, said lever being movable in a slot in the key-knob and carrying a cross-head above the said knob.

455,322. Trolley-Pole Stand; Jas. R. Griffiths, of Allegheny Pa. Application filed Jan. 20, 1891. A trolley-pole stand, consisting of a supporting frame having a socket, the trolley pole fitted in said socket and adapted to move therein, and means to permit a lateral movement of the trolley pole.

455,339. Conductor for Electric Railways; Walter H. Knight, of Cleveland, O. Application filed May 11, 1885. An electric railway having a slotted conduit flush with the street surface and having its inner surface adapted to shed water away from the slot, with the insulators placed at intervals, and having a water-shed flange, and the electric conductor connected thereto having a bare contact surface parallel with said slot.

455,340. Electric Railway; Walter H. Knight, of New York. Application filed May 11, 1885. The invention consists in a contact device carried by the vehicle having its outer extremity pressed into contact with the line conductor and guided along it and its inner extremity having a free laterally moving and swiveling connection to the vehicle, permitting all the necessary



No. 455,341.—Electric Railway.

movements to accommodate the device to the irregular paths followed by its opposite ends, respectively.

455,341. Electric Railway; Walter H. Knight, of New York. Application filed April 29, 1887. An electric street railway conduit inclosing a line conductor and constructed of two parts; first a sub-structure beneath the pavement, consisting of yokes placed at intervals with intermediate filling and supporting the conductor by projecting insulators holding it free from the side walls, and, second, slot rails extending through the pavement forming the upper part of the conduit, the said insulators being so placed that the slot rails serve as a water shed, guarding them from matter entering behind the said rails. (See illustration.)

455,342. Electric Railway; Walter H. Knight, of New York. Application filed Oct. 16, 1888. The combination, in a conduit system of electric railway, of a series of transverse yokes with a rail of the girder type forming a track rail and also one of the slot rails, and an angular rail having an upright web forming the opposite slot rail, the said slot rails resting on and supported by the yokes, and an isolated supply conductor in the conduit to one side of the slot where it is shielded by said rails.

455,343. Electric Railway Plow; Walter H. Knight, of New York Application filed March 5, 1889 The combination, with an electrically propelled vehicle and a line conductor, of a transversely-moving support and a contact device pivoted thereto on a vertical axis and extending to connect with the supply conductor.

455,366. Combined Fuse-block and Incandescent Lamp; Horace E. Swift, of Boston, Mass. Application filed Sept. 29, 1890. In accordance with this invention two fuse wires are secured to a bar of insulation, preferably one at each side, and the handle is socketed to receive this bar.

455,398. Quadruplex Telegraphy; Chas D. Haskins, of Brooklyn, N.Y., Assignor to the Western Electric Company of Chicago, Ill. Application filed Nov. 19, 1887. A local circuit containing a battery, a sounder, and the contacts of two relays, one of said relays being a quadruplex neutral relay and the other being a relay with its coils included in a circuit with a special helix or third winding upon the electromagnet of the quadruplex neutral relay, whereby the local circuit through the sounder is closed when the armature levers of both relays are simultaneously on their back contacts.

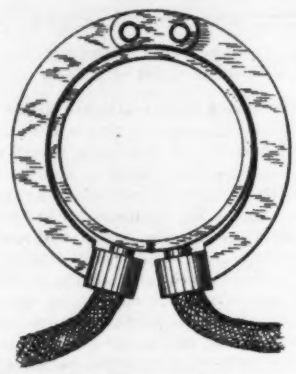
455,420. Method of Electric Welding; Elihu Thomson, of Swampscott, Mass., Assignor to the Thomson Electric Welding Company, of Maine. Application filed Feb. 19, 1891. Method of electric welding, consisting in applying a local cooling effect to the work in the heating portion of the circuit near the points of application of the current bearing electrodes or contacts.

455,421. Securing Metal Bands on Wooden or other Articles; Elihu Thomson, of Swampscott, Mass., Assignor to the Thomson Electric Welding Company, of Maine. Application filed Feb. 24, 1891. The method of applying a metal retaining band, ring or hoop, consisting in welding the same after it is in place on the article or object. (See illustration.)

455,446. Grave Annunciator; William H. White, of Topeka, Kan. Application filed May 22, 1890. The combination, with a coffin, of a flue composed of two separable sections, the one above the other, the lower of the said sections communicating with the coffin, a contact maker, and a diaphragm within the lower section, a valve within the said diaphragm mechanically connected with the said contact maker, a wire passing upward from the said contact-maker and through the said diaphragm and upper section of the flue, and an annunciator connected with said wire.

455,447. Conduit for Electric Railways; William Bradley, of Fort Wayne, Ind. Application filed Nov. 24, 1890. A conduit for electric railways, consisting of a box or pipe constructed in two sections secured to each other, a projection of the upper part over the lower section adapted to form a slot for the trolley lever to pass through and be operated, a standard attached to the interior of the conduit, adapted to support and firmly hold a flange, a trolley wire provided with flanges rigidly secured thereto, a trolley lever adapted to pass into the conduit through said slot and provided with a trolley adapted to run on and be confined to the wire, and insulating material adapted to confine the current to the conducting wires. (See illustration.)

455,454. Electric Railway; Edwin Wilbur Rice, Jr., of Lynn, Mass., Assignor to the Thomson-Houston Electric Company, of



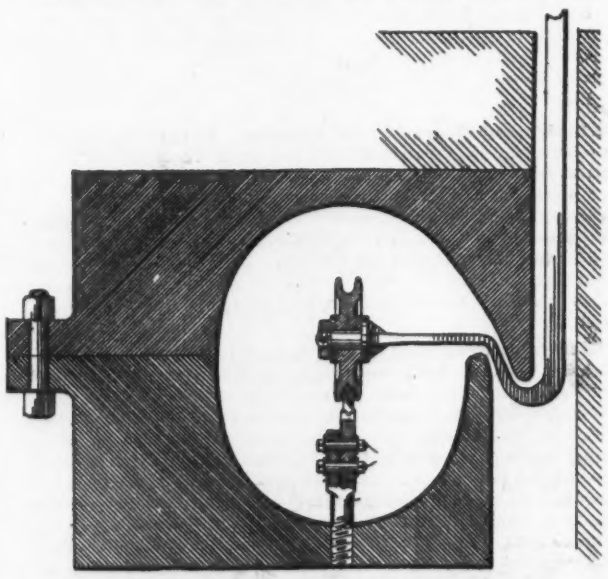
No. 455,421.—Securing Metal Bands on Wooden or Other Articles.

Connecticut. Application filed March 30, 1891. An electric railway, comprising two or more supply-conductors parallel therewith, connected, respectively, to generators of different electromotive forces, and a vehicle on the railway provided with apparatus for bringing the propelling motor into circuit with either of said supply conductors at will.

455,488. Friction-Gearing for Dynamos; Frederick L. McGahann, of Indianapolis, Ind. Application filed Dec. 26, 1890. In a dynamo, an armature rigidly mounted on a shaft having bearings in a circular ring or plate connected to such armature between the bobbins and shaft, in combination with a friction roll journaled in bearings at one side of the armature shaft and adapted to contact with the inner face of the circular plate for driving the armature.

455,510. Train-Signaling Apparatus; Linwood F. Jordan, of Somerville, Mass., Assignor of one-half to Henry B. Bennett, of Portland, Me. Application filed Nov. 16, 1889. A railway car telegraph, comprising a single stroke bell, a battery, a push button and a switch for connecting it in place of the first battery, a three-wire circuit running from the engine to the cars, a Trembly bell located in each car and normally included in two of the wires of the circuit, and a switch located in the car for including the bell in the circuit with the third wire.

455,517. Multipolar Dynamo; Andrew L. Riker, of New York. Application filed Feb. 7, 1891. A blank for building up a continuous multipolar field magnet, said blank being a stamped-out plate of soft sheet iron of small size, comparatively, to the



No. 455,447.—Conduit for Electric Railways.

circumference of the field, and comprising a core portion, a coil space, pole pieces on each side thereof, and an extension from one pole piece provided with a bolt hole equidistant between adjacent cores when the blanks are assembled, so that the parts will all register when some of the blanks forming a single segment of the field are reversed with respect to the others.

455,518. Carbon Brush and Holder Therefor; Andrew L. Riker, of New York. Application filed March 25, 1891. A holder for the carbon brushes of a dynamo or motor, comprising a mortised frame or box, through which the brush passes, two upright guide-rods fastened to said frame, a cap fitting over the end of the brush and movable on said guide-rods, a spring surrounding one of the rods and bearing on said cap and an adjusting-nut on said rod.

455,520. Pulsating-Current Reciprocating Electric Engine System; Charles J. Van Depoele, of Lynn, Mass. Application filed March 23, 1889. The combination, with a source of pulsating or rising and falling currents of an electro magnetic-reciprocating engine having a motor coil or coils and a magnetic piston moved within the coil or coils in synchronism with the rise and fall of energy therein.

455,532. Self-Winding Electric Clock; Fred Leon Gregory, of Niagara Falls, Assignor of one-half to John C. Rich, of Auburn, N. Y. Application filed April 2, 1891. In an electric clock actuating mechanism the combination with the clock movement having a ratchet wheel, and with an electromagnet and its electrical circuit, of the vibratory rock shaft carrying the clock actuating weight in proximity to the poles of the magnet and having a pawl engaging the ratchet wheel to actuate the clock movement on the descent of said weight, and a locking switch actuated by the descending weight to close the circuit for raising the weight.

455,559. Lamp Socket and Switch and Circuit Closer Therefor; Henry Price Ball, of Brooklyn, N. Y., Assignor to the Edison General Electric Company, of New York. Application filed Dec. 16, 1890. A lamp-socket having terminals for the circuit, a potential or disruptive circuit closer in the base of the socket, consisting of two conducting members, a film of insulating material between the members, and means operated by insertion of the lamp for moving the parts of said potential or disruptive circuit closer near together.

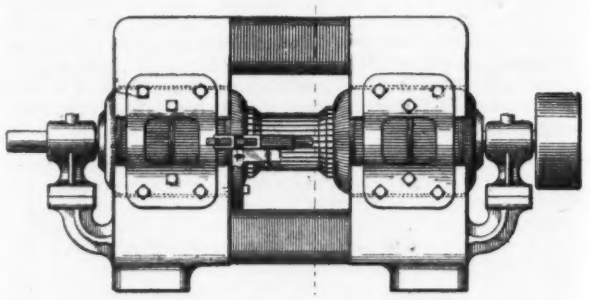
455,575. Electric Meter; Johan W. Th. Olan, of New York, Assignor of one-half to Edward H. Johnson, of same place. Application filed Dec. 29, 1890. The method of measuring electricity, which consists in decomposing an electrolyte into its constituent gases at successive pockets in a rotating body by means of the current to be measured, rotating said body by the buoyancy of the gases thus produced, and moving an indicator in accordance with movement of said body.

455,576. Electric-Arc Lamp; Johan W. Th. Olan, of New York, Assignor of one-half to Edward H. Johnson, of same place. Application filed Jan. 12, 1891. The combination with the carbons or electrodes of an arc lamp and inclosing globe therefor, of a tube extending from the base thereof and containing a column of mercury equal in height to a barometric mercury column, a float in said mercury supporting the movable electrode of the lamp and carrying or forming an armature and a coil or magnet adapted to attract said armature.

455,581. Electric Motor-Car Truck; John F. Sterling, of Akron, O. Application filed March 9, 1891. A car truck having the frame side sills arranged outside of the wheels and connected together by two cross beams between the wheels, and an electric motor arranged between the cross-beams and adjustable relatively thereto, means for adjusting said motor, the bevel pinion on the armature shaft and the bevel wheel on the truck-wheel axle arranged to intermesh with said pinion.

455,680. Electric Belt; Charles A. Bogardus, of Syracuse, N. Y. Application filed Feb. 24, 1891. An electric belt having a flat zinc folded over on one end, a covering of absorbent material, a wire wound around over the absorbent, then twisted at one end of the zinc, then bent inwardly, forming hooks, and bent to form forward projecting points.

455,683. Transmission of Alternating Currents of Different Phase; Michael Von Dolivo-Dobrowälsky, of Berlin



455,726.—Electric Motor or Generator.

Germany, Assignor to the Allgemeine Elektricitäts Gesellschaft, of same place. Application filed March 28, 1891. The combination of a dynamo-electric machine having a plurality of coils or sets of coils in which independent alternating currents of relatively differing phases are induced, a transformer provided with as many primary coils as there are induction coils or sets of coils in the dynamo, and with a smaller number of secondary cells, separate connections between the induction coils of the dynamo and the primary transformer coils, and mains connected to the secondary coils of the transformer.

455,693. Galvanic Battery; Henry Clay Sample, of Ravenswood, Assignor to Hugh W. Matthews, of Chicago, Ill. Application filed Dec. 2, 1889. A galvanic battery having a circular peripheral wall, and an end wall extending from the centre of the cell to the outer wall.

455,696. Switch-Board for Electric Fence Stations; David H. Wilson, of Normal, Assignor to the American Electric Fence Company, of Chicago, Ill. Application filed Aug. 25, 1890. A switch-board having posts thereon adapted to have secured thereto wires extending from an induction coil or other electrical generator, one of such posts electrically connected with the coil of a magneto-alarm bell, a wire extending from such coil to a pivotal arm, other pivotal arms pivoted on the first-named pivotal arm, each and every of such pivotal arms adapted to be brought into contact with posts, each of such posts forming a strand of an electric fence, and a second pivotal arm electrically connected with the other of the first-named posts, such last-named pivotal arm being adapted to be brought in contact with posts placed in the switchboard, one of such posts having a ground wire electrically connected thereto and the other of such posts having the other end of the wires forming the strands of the fence electrically connected thereto.

455,711. Electric Motor; Lemuel G. Goode, of Jersey City, N. J., Assignor to the Paterson Electrical Manufacturing Company, of New Jersey. Application filed Aug. 22, 1890. An electric circuit comprising a plurality of stationary coils, a reciprocating or oscillating armature, a commutator, a movable brush carried by the armature and having two contact surfaces for alternate contact with the commutator and means for automatically moving the brush to change the position of its contact surfaces for reversing the direction of the armature.

455,722. Support for Telephones; William J. Myers, of Allegheny, Pa., Assignor to the R. D. Nuttall Company, of same place. Application filed June 3, 1890 A support for telephone-receivers, formed of a vertical bar, a bracket longitudinally adjustable thereon and having a socket thereon and a rest or support formed of wire and having the ends thereof twisted into a spiral and entering said socket.

455,726. Electric Motor or Generator; Walter F. Brown, of St. Paul, Minn., Assignor of two-thirds to Wm. F. Bailey, Geo. N. Bailey and Chas. N. Nitterauer, all of same place. Application filed Aug. 21, 1890. In an electric motor or generator, the combination of two pairs of pole pieces arranged in the same plane, cores connecting the adjacent pole pieces, field-magnet coils upon said cores, two armatures arranged upon a common shaft, one between each pair of pole pieces, a common commutator arranged between said armatures upon said shaft, the segments of the commutator being connected to the windings of said armature lying in the same plane, but of opposite polarities, and brushes bearing upon said commutator in a plane at right angles to the plane passing through the centres of the pole pieces. (See illustration.)

Copies of the specifications and drawings complete of any patent mentioned in this record—or of any other patent issued since 1886—can be had for 25 cents. Give date and number of patent desired, and address The W. J. Johnston Co., Ltd., Times Building, N. Y.

The Edison Electric Light Company vs. The United States Electric Lighting Company.—Decision of Judge Wallace in the U. S. Circuit Court, July 14, 1891.

Two claims of letters patent, No. 223,898, granted Thos. A. Edison, Jan. 27, 1880, for an improvement in electric lamps, are in controversy in this suit. These are claims 1 and 2. It is not asserted for plaintiff that the defendant infringes the other claims of the patent, consequently they will require no attention further than to see whether their terms may assist in defining the meaning of the claims in litigation.

The plaintiff contends that these claims are for fundamental inventions of great merit, and are entitled to a construction by which every incandescent lamp, for electric lighting, consisting essentially of a filamentary carbon burner, hermetically sealed in a glass vacuum chamber, is within their terms. The defendant contends that unless the claims are limited to narrow inventions, not employed by the defendant, they are invalid for want of patentable novelty. The questions of the validity and scope of the patent have been adjusted in the courts of England and Germany with a diversity of opinion by the judges who have considered them. The specification is a perplexing one. The difficulty lies in its shadowy demarkation of the line between the essential and non-essential feature of the invention described. It catalogues a number of discoveries which Mr. Edison had made; it sets forth some of the essential features of the lamp, and then it leaves to be found by inference from generalities what the elements are of the combinations included in the extremely elastic terms of the two important claims.

Nevertheless, when a sufficient knowledge of the prior state of the art to which it relates has been acquired, the new departures from the old devices which it describes, and which, presumably, the inventor proposed to incorporate into the claims of his patent, are reasonably apparent. The specification states that the object of the invention is "to produce electric lamps giving light by incandescence, which lamps shall have a high resistance so as to allow of practical subdivision of the electric current into numerous small units and their conversion into luminous centres. By practical subdivision is meant a distribution and division of the current and its conversion into lights comparable with those of ordinary gas jets, on a scale and under conditions of convenience and economy adequate to a system of illumination for domestic purposes in villages and cities analogous to that of gas. Prior to 1879 there was no method known by which this could be done practicably. The problem involved the perfection of devices for the proper distribution and regulation of the current as well as those for translating it into the light. No reference to the pre-existing devices for generating electricity, conducting it to the translating devices, or regulating its pressure and quantity, is necessary except to state that the principles governing the relation of the resistance of translating devices to the character of the circuit in which they are arranged, whether in series or in multiple arc, were well known to electricians and had been applied in various forms of electrical apparatus. They were two well-known devices for converting the current into light—the arc lamp and the incandescent lamp. In the former the current is forced to leap an air gap separating two conductors, usually of carbon, and in overcoming the resistance of the air space heats the adjacent surfaces of the conductors and produces a light of great intensity. In the latter light is produced by the incandescence of an electrical conductor, a conducting strip of burner, placed in a continuous circuit through the current passes and which develops heat by its resistance to the flow. The arc lamp was suitable for use in streets, open spaces and large halls, but its light was too concentrated and powerful for the illumination of dwellings or of rooms of small dimensions. It was the generally accepted opinion of electricians that the hope of progress in the subdivision of the electric light was to be found in modifying the features of the arc lamp. The reason for this conclusion need not be mentioned; it suffices to say that Mr. Lane-Fox in England, and Mr. Edison in this country, seem to have been the only notable dissidents, and each of them had expressed the conclusion that subdivision might be accomplished by the incandescent lamp when provided with a conductor of high resistance and small radiating surface arranged in system of multiple arc. Lane-Fox had set forth the advantages of such a lamp in three patents granted to him in England and two in October, 1878, and one in March, 1879, and in a letter to the *London Times*, published in December, 1878; and Mr. Edison had done so in a patent granted to him in France, May 28, 1879, for improvements in electric lighting.

By arrangement in multiple arc no greater electromotive force is required for a large number of translating devices than for a single one, and the amount of current can be graduated to the number employed; consequently, a lamp with a conductor of high resistance can be utilized as efficiently as one with a conductor of low resistance. Higher resistance in the conductor permits the use of a weaker current, and, consequently, of smaller and less expensive main conductors. With a small surface of conductor less energy is required to produce a candle power, and the small incandescent mass will radiate a moderate light, like the domestic lamp. Electricians knew how to make conductors of high resistance, and how to make them with a small radiating surface. They knew that with the materials of the same specific resistance the total resistance of the conductor could be varied by varying its length and cross section. They knew what materials were preferable and what processes of treatment to make conductors of high or low resistance.

If they had only known how to construct a lamp in which the conductor would have adequate mechanical strength and durability for practical commercial use, while having the small radiating surface and high resistance desirable, there would have been nothing wanting and electric lighting by incandescence would soon have been an accomplished fact. Although Lane-Fox and Edison had contributed to the state of the art the recognition of the principle that the conductor must have high resistance and small radiating surface, and each of them had embodied the principle in lamps for which they had severally obtained patents, neither of them had invented a lamp which satisfactorily embodied all the conditions of success, because a burner of the necessary material, form and complementary adjuncts was yet to be devised. As to material, experiments had been tried with platinum, iridium and alloys of these metals, and with carbon of various kinds. It was known that platinum, being a poor conductor, could be readily brought to incandescence by the electric current, but to do so it was necessary to raise it to a temperature very near the fusing point, and a minute increase would melt it. On the other hand, carbon was known to possess at an equal temperature much greater power of radiation than platinum, but the difficulty was that it would combine with oxygen at high temperature and rapidly disintegrate. It could only be used, therefore, in a vacuum was practically unattainable. From the earliest lamp (disregarding the Geisler tube, because it has no burner in the true sense), patented in England by King in 1849, to the latest examples, like those of Lane-Fox or Edison's platinum lamp, patented in 1878–9, the history of the art show a variety of experiments to perfect a lamp in which a carbon burner or a platinum burner would have sufficiently long life for practical requirements. The result of these experiments may be succinctly shown by quoting two well-known electricians. Mr. Schwendler, in an article published in 1879 in the *Telegraphic Journal*, said: "Unless we shall be fortunate enough to discover a conductor of electricity with a much higher melting point than platinum, and the specific weight and specific heat of which conductor is also much lower than for platinum, and which at the same time does not combine at high temperatures with oxygen, we can scarcely expect that the principle of incandescence will be made use of for practical illumination." Mr. Sawyer, in a patent to Sawyer & Man, granted in June, 1878, said: "At the present day it is not new to produce a light by causing the electric current to heat a carbon conductor to incandescence in a vacuum, or in nitrogen, or in other gas; but no lamp has yet been devised which would be practically operative, and for these reasons: First, the methods which have been adoptod for charging the lamp with the artificial atmosphere, such as a displacement of mercury, water or air by the gas, or the combustion of phosphorus in the lamp, are imperfect. A perfect vacuum is unattainable. Some oxygen or other element or compound remains in the lamp, and slow consumption or disintegration takes place, for the remaining gas or vapor other than hydrogen or nitrogen attacks the carbon, which, in turn, is decomposed, with a result of depositing some carbon upon the globe and setting free the oxygen to attack fresh carbon. Second, it has been found practically impossible under the varying degrees of heat and pressure to maintain perfect joints, and the result is that expansion of the artificial atmosphere by the heat from the luminous conductor expels a portion of the same, and the contraction of the atmosphere upon cooling causes a portion of the external air to penetrate the globe, thus supplying oxygen which at the least lighting feeds upon the carbon. Third, the unequal expansion of the carbon and its holders has resulted in fractures of the former, so that however perfect the atmosphere in the globe, the lamp has never been permanent."

The most advanced type of carbon burner lamps in 1875 were the lamps of Lodyguine or of Konn, and until the spring of 1879 lamps like those of the Sawyer & Man patent or the patents of Mr. Farmer. It was thought to be the merit of Lodyguine's lamp that it obviated the difficulty of the short life of the burner by using two burners, rods of diminished section at the luminous focus, on a glass receiver, hermetically sealed and filled with nitrogen, electrically arranged so that the current would be passed to the second carbon when the first had been consumed. Konn provided his lamp with five carbon burners in the form of rods or pencils, and devices for bringing them successively into circuit. In the lamp of Sawyer & Man the carbon burner was a rod or pencil maintained in a globe and its stopper (both of glass) were held together by a clamping device. In the lamp of the patents granted to Mr. Farmer, in March, 1879, the burner was a carbon rod or pencil inclosed in a globe filled with hydrogen or other analogous gas, and the globe was closed by a rubber stopper. In none of the lamps, except the one described in Mr. Edison's prior French and English patents of 1879, had any attempt been made to make the vacuum chamber wholly of glass with the parts sealed together by fusion, or to seal the conducting wires leading to the burner through the glass by fusion of the glass. The impracticability of maintaining a carbon burner under such conditions that it would be sufficiently durable has apparently so impressed those who were studying lighting by incandescence that as late as in the early part of 1879 both Lane-Fox and Edison were trying to perfect a burner of other material. Edison's burner in his French patent of May 28, 1879, was of platinum wire coiled upon a bobbin composed of an infusible oxide, and Lane-Fox's burner in his patent of May 14, 1879, was of platinum-iridium alloy, or of spiral strips of metal surrounding a tube of glass, fire-clay, steatite or lime, with the surface of the metal strips covered with asbestos or some vitreous material.

This cursory view of the prior state of the art is sufficient for an intelligent reading of the specification. The specification describes the general nature of the invention as follows:

"The invention consists in a light-giving body of carbon wire or sheets coiled or arranged in such a manner as to offer great resistance to the passage of the electric current, and at the same time present but a slight surface from which radiation can take place."

"The invention further consists in placing such burner of great resistance in a nearly perfect vacuum to prevent oxidation and injury to the conductor by the atmosphere. The current is conducted into the vacuum bulb through platina wires sealed into the glass."

"The invention further consists in the method of manufacturing cerbon conductors of high resistance, so as to be suitable for giving light by incandescence, and in the manner of securing perfect contact between the metallic conductors or leading wires and the carbon conductors."

The specification then recites that previously light by incandescence has been obtained from rods of carbon of one to four ohms resistance placed in closed vessels in which the atmospheric air had been replaced by gases that did not combine chemically with the carbon; that the vessels holding the burner had been composed of glass cemented to a metal base; that the connection between the leading wires and the carbon had been obtained by clamping the carbon to the metal; that the leading wires have always been large, so that their resistance should be many times less than the burner, and generally the attempts of previous persons had been to reduce the resistance of a carbon rod. It then points out the disadvantages of such a lamp, stating that it could not be worked in great numbers in multiple arc without the employment of main conductors of enormous dimensions; that, owing to the low resistance, the leading wires have to be of large dimensions and good conductors, and a glass globe cannot be kept tight at the place where the wires pass in and are cemented, and consequently the carbon is consumed because there must be almost a perfect vacuum to render it stable, especially when it is small in mass and high in electrical resistance; and that the use of gas in the receiver at the atmospheric pressure serves to destroy the carbon by attrition.

The specification then states in substance that the patentee proposes a new departure; that he has discovered that even a cotton thread properly carbonized and placed in a sealed glass bulb exhausted to one-millionth of an atmosphere offers from 100 to 500 ohms resistance to the passage of the current, and that it is absolutely stable at very high temperatures; that if the thread be coiled as a spiral and carbonized, or if a fibrous vegetable which will leave a carbon resistance after heating in a closed chamber be so coiled, as much as 2,000 ohms resistance may be obtained without presenting a radiating surface greater than three-sixteenths of an inch; that if such fibrous material be rubbed with a plastic compound of lampblack and tar its resistance may be made high or low, according to the amount of lampblack placed upon it; that carbon filaments may be made by a combination of tar and lamp black, the latter being previously ignited in a closed crucible for several hours, and afterward moistened and kneaded until it assumes the consistency of thick putty; that small pieces of this material may be rolled out in the form of wire as small as seven one-thousandths of an inch in diameter and over a foot in length, and the same may be coated with a non-conducting, non-carbonizing substance and wound on a bobbin, or as a spiral, and the tar carbonized in a closed chamber by subjecting it to high heat, the spiral after carbonization retaining its form; that he has carbonized and used cotton and linen thread, and splints, papers, coiled in various ways, also lampblack, plumbago, and carbon in various forms, mixed with tar and kneaded so that the same may be rolled out into wires of various lengths and diameters; that each wire should be uniform in size throughout; and all those forms are fragile and cannot be clamped to the leading-in wires with sufficient force to insure good contact and prevent heating; that if platinum wires are used and the plastic lampblack and tar material be moulded around it in the act of carbonization, there is an intimate union by combination and by pressure between the carbon and platinum, and nearly perfect contact is obtained without the necessity of clamps; that the burner and leading wires should be connected to the carbon ready to be placed in the vacuum bulb, and when fibrous material is used the plastic lampblack and tar should be used to secure it to the platina before carbonizing.

The specification proceeds as follows:

"By using the carbon wire of such high resistance I am enabled to use fine platinum wires for leading wires, as they will have a small resistance compared to the burner, and hence will not eat and crack the sealed vacuum bulb. Platina can only be used, as its expansion is nearly the same as that of glass."

"By using a considerable length of carbon wire and coiling it, the exterior, which is only a small portion of its entire surface, will form the principal radiating surface; hence I am able to raise the specific heat of the whole of the carbon, and thus prevent the rapid reception and disappearance of the light, which on a plain wire is prejudicial, as it shows the least unsteadiness of the current by the flickering of the light, and if the current is steady the defect does not show."

The specification then gives direction for carbonizing the carbon thread in a manner to prevent its distortion, for blowing a glass bulb over it after it is formed, for exhausting the glass bulb, and for hermetically sealing the bulb when a high vacuum has been reached.

The claims are as follows:

"1. An electric lamp for giving light by incandescence, consisting of a filament of carbon of high resistance, made as described, and secured to metallic wires as set forth.

"2. The combination of carbon filaments with a receiver made entirely of glass and conductors passing through the glass, and from which receiver the air is exhausted, for the purpose set forth.

"3. A carbon filament or strip coiled and connected to electric conductors so that only a portion of the surface of such carbon conductors shall be exposed for radiating light, as set forth.

"4. The method herein described of securing the platina contact-wires to the carbon filament, and carbonizing of the whole in a closed chamber, substantially as set forth."

The specification is addressed to those who were skilled in the art to which it relates; who appreciated the advantages of arranging incandescent lamps in a system of multiple arc, and of providing the lamp with a burner of high resistance and small radiating surface; who knew how high resistance, both specific and total, is imparted to a conductor; who knew that the rods, pencils, or other forms of carbon burners previously used had not been designed to embody the principle of high resistance; who knew how desirable it was to maintain the burner in a perfect vacuum, or in gases that would exclude the oxygen; who knew what had been attempted and had proved impracticable in that behalf; who knew that such materials as are mentioned in the specification (even the tar-putty compound seems to have been used in one process) would compose a carbon of high resistance when subjected to a proper process of carbonization; and who knew how to practice proper processes for the carbonization of such materials.

Read by those having this knowledge, the radically new discovery disclosed by the specification is that a carbon filament as attenuated before carbonization as a linen or cotton thread, or a wire seven one-thousandths of an inch in diameter, and still more attenuated after carbonization, can be made which will have extremely high resistance and be absolutely stable when maintained in a practically perfect vacuum. It informs them of everything necessary to utilize this discovery and incorporate it in a practical lamp. It describes, with the assistance of the recital in the second claim, as the vacuum in which the burner is to be maintained a bulb made wholly of glass, exhausted of air, sealed at all points by the fusion of the glass, and in which platinum leading wires are sealed by the fusion of the glass. It describes the materials of which the burner is to be made and instructs them that the materials are to be shaped into their ultimate form before carbonization. It describes the use of platinum for leading wires, and a method of securing the leading wires and fila-

ments, intended to dispense with clamping, which consists in molding tar-putty about the joints and carbonizing the whole in a closed chamber. Besides stating that the resistance of the burner will be greatly increased and the radiating-surface still be kept within moderate limits by coiling it in the form of a spiral, the specification states that by increasing the lengths of the filament coiled the exterior only will be the principal radiating surface, and greater steadiness of illumination will be promoted.

The first claim must be read with several limitations. The filament is to be made of carbon of high resistance; that is, as the experts agree, of high specific resistance. The filament is to be made as described, that is, the materia s are to be of some of the kinds described, and are to be shaped in filamentary form and then carbonized. The filament is to be secured to metallic wires according to the method of the patent, because the claim implies the elements of a globe and metallic conductor arranged in circuit with the burner, otherwise the combination would not be operative, and it would have been needless to specify the securing of the metallic wires to the filament unless it was intended to insert into the claim the specific method of doing so emphasized in the specification.

The defendant does not infringe this claim, if for no other reason, because the leading wires in its lamps are not secured to the filament according to the method of the patent, that is, by cement carbonized in situ, by clamps such as the specification condemns.

The second claim is broad enough in its phraseology to secure the real invention described in the specification, and can be read consistently with its language so as to impart into it every essential limitation.

It was a remarkable discovery that an attenuated thread of carbon would possess all the long-sought qualities of a practical burner when maintained in a perfect vacuum. The extreme fragility of such a structure was calculated to discourage experimentation with it, and it does not detract in the least from the originality of the conception that previous patents had suggested that thin plates, or pencils, or small bridges could be used. The futility of hoping to maintain a burner in vacuo with any permanency had discouraged prior inventors, but Mr. Edison is entitled to the credit of obviating the mechanical difficulties which disheartened them, but what he did in this respect was a matter of only secondary merit, and was no longer new in the art because he had already disclosed it in his French and English patents. What he actually accomplished was to unite the characteristics of high resistance, small radiating surface, and durability in a carbon conductor by making it in a form of extreme tenuity, out of any such materials as are mentioned in the specifications, carbonizing it, and arranging it as he had previously arranged his platinum burner in an exhausted bulb made wholly of glass and sealed at all points, including those where the leading wires entered, by the fusion of the glass. He was the first to make a carbon of materials and by a process which was especially designed to impart high specific resistance to it; the first to make a carbon in the special form for the special purpose of imparting to it high total resistance; and the first to combine such a burner with the necessary adjuncts of lamp construction to prevent its disintegration and give it sufficiently long life. By doing those things he made a lamp which was practically operative and successful, the embryo of the best lamps now in commercial use, and but for which the subdivision of the electric light by incandescence would still be nothing but the ignis fatuus which it was proclaimed to be in 1879 by some of the learned experts who are now witnesses to belittle his achievement and show that it did not rise to the dignity of an invention.

The coiled form of the burner is only an alternative feature and is not a constituent of the second claim. It is the subject of the third claim. Nor is the bent form or any form other than the filamentary. It may be that in the haste, which has always seemed to characterize Mr. Edison's efforts to patent every improvement, real or imaginary, which he has made or hoped to make, he had not stopped to reflect when he framed his application for the patent that the filamentary burner would do its work just as well uncoiled as coiled, provided the same length and cross-section were used. It is true that it is said in the general statement of the nature of the invention that the burner is so "coiled or arranged" as to offer high resistance and present a small radiating surface; but this description is satisfied by any arrangement, whether by coiling a considerable length in a small globe or using the same length uncoiled in a large globe, by which sufficient total resistance is obtained from a filament of small diameter. It certainly would not involve invention to omit the coiling and elongate the globe; hence, it is manifest that the invention described is the same thing essentially, whether the coiled form is used or not. The language is satisfied if the burner is filamentary and so arranged as to offer great resistance and slight radiation, without importing into it anything which is not of the essence of the invention. No precise limitation upon the maximum diameter of the filament can be defined from the specification or is required as an element of the claim. The specification mentions by way of illustration the threads of linen or cotton which become more attenuated after carbonization, and the carbon wire which after carbonization would be from four to five one-thousandths of an inch in diameter, while the smallest rods of carbon previously known were about a millimetre in diameter, thus having a cross-section fifty times as great as the carbon wires. It is to be implied from the suggestions in the specification that it is to have sufficiently high total resistance for efficient use when the lamps are arranged in multiple arc, and to be used with leading wires of fine platinum. The claim is not limited to a carbon filament made of non-fibrous material. The conductors of the claim are the platinum wires mentioned in the specification. The receiver is the vacuum described in the specification. The peculiar method of securing the conductors to the filament, made a constituent of the first claim, is not imported into the second claim. A more exact interpretation of the meaning of the claim than has thus been indicated is not necessary in the present case, because each of the three lamps representing the kinds used by the defendant embodies the invention of the claim as thus interpreted.

It is of little import what Mr. Edison or his patent solicitor may have thought about the meaning of the claim during the pendency of the application for a subsequent patent, or that Mr. Edison may have supposed a resistance as high as 100 ohms in the burner would be required for use with the means of distribution which he expected to employ with his system of lighting. There are many adjudicated cases in which it appears that the inventor builded better than he knew; where a patent has been sustained for an invention the full significance of which was not appreciated by the inventor when it was made. In the case of the Bell telephone patent there was great room for doubt whether the speaking telephone had been thought of by Mr. Bell when he filed his application for a patent, but the Court said: "It describes apparatus which was an articulating telephone, whether Bell knew it or not." 88 Blatch., 532.

The nearest approach in the prior art to the invention of the second claim is undoubtedly the lamp of Edison's French and English patents with a platinum burner. It seems almost preposterous to argue that the substitution of the carbon filament for the platinum burner of that lamp was an obvious thing to electricians. It would have been probably if there had been such a thing as a filamentary carbon in the prior art. But the nearest approximations to it were the ribbon-shaped carbon burner of low resistance of Mr. Farmer (which was not a part of the prior art, but an isolated example known only to a select few) and the low resistance carbon rod burners of the patent of Sawyer & Man.

Undoubtedly the improvements that have been made in the art, such, for instance, as the method of electrical carbonization of the filament, since Mr. Edison's invention, have been of great value, and the perfected commercial lamp of to-day is far superior to the one which could be made by applying to the description of the patent all the knowledge and skill then possessed by those to whom it was more particularly addressed. But as was said by Bowen, L. J., in the Court of Appeals in England, "the evidence shows that lamps made solely on the patent will and do succeed, although subsequent improvements have been ingrafted on the original design." It is impossible to resist the conclusion that the invention of the slender thread or carbon as a substitute for the burners previously opened the path to the practical subdivision of the electric light.

The questions which have seemed the most meritorious of those argued at the bar have now been considered. Others, to which no reference has been made, have not been overlooked, and may be dismissed without discussion, and with the single remark that nothing which has been presented by the voluminous proofs and the exceedingly able and elaborate arguments of counsel seems to supply any valid reason for refusing to decree for the plaintiff.

The usual decree for an injunction and accounting is accordingly ordered.